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NEW YORK, MARCH, 1887.

THE bills before Congress appropriating money for new cruisers for the Navy, and those providing for new heavy guns for both the Navy and the Army and for additional defenses on the sea coast, have not passed nor even assumed final shape as the month closes. There is a considerable difference between the measures before the Senate and the House, and it is quite impossible to predict what shape these bills may receive at the hands of conference committees, or what action may be taken on them in the hurry of the last few days of the session.

That some action may be taken which will make it possible to begin work on the new guns which all parties seem to agree are needed by the country, is to be hoped for. If the guns must be had, the sooner work is begun the better.

THE discussions at the various railroad club meetings which are reported elsewhere, like those at the January meetings, failed to bring out much beyond expressions of individual opinion. Three or four roads were reported as additions to the list of those which are experimenting with systems of steam heating, but nothing new was given as to the results on those roads which have already tried such systems. Large attendances showed the general interest felt in the subject.

THE terrible accident at West Hartford, on the Central Vermont Railroad, in which over 40 people were killed, most of them being burned to death, has increased the public interest in methods of car heating which was aroused by the accidents at Republic and West Springfield early in January. There is a general demand for legislative action on this question, and in several States such action seems to be imminent. In New York, resolutions have been passed requiring the Railroad Commission to investigate the question and report to the Legislature.

IN the case of the Republic accident the Coroner's jury has brought a very severe verdict against the railroad company, charging it with using defective machinery, cars in poor condition and defective and dangerous heating apparatus. The West Hartford disaster, according to the Vermont Railroad Commissioners, who have investigated the accident, was primarily due to a broken rail; the loss of life, they find, was due chiefly, if not entirely, to the burning of the cars, which were set on fire from the heaters. The Commissioners recommend the disuse of the old stoves and heaters entirely, and the substitution of some of the steam heating or other safety systems.

IN nearly all the discussions in the daily newspapers and elsewhere, it seems to be assumed that the only possible method of heating cars safely is by steam taken from the locomotive, or at least from some source outside of the passenger cars. With this view, as has been heretofore noted, many railroad men of experience are not ready to concur, and it cannot be denied that their objections deserve careful consideration, even if they do show a somewhat too conservative disposition to condemn new methods and to keep to the old lines.

That some action must be taken on the safe-heating question is evident, and if the railroad companies do not take it voluntarily the chances are that they will be compelled to do it by law. The present danger is that, in one or several States, crude measures will be passed which will make endless trouble for the railroads and probably fail to accomplish their object. A general disposition on the part of managers to institute a reform without compulsion will be the best preventive of bad legislation.

THE usual line of promotion to the higher offices on railroads in this country has been either through the traffic department or the chief engineer's office; in the latter case an apprenticeship being generally served in the transportation department, either as division or general superintendent. There are very few cases in which the motive power department has been called upon, and the general managers or presidents who have been through that branch of the railroad service can be counted upon the fingers. The New York, Lake Erie & Western Company has just made a new precedent by promoting Mr. R. H. Soule, its Superintendent of Motive Power, directly to the office of General Manager. In this case, however, the promotion may be taken, not so much as a concession to the importance of the department, as to a recognition of work well done, and thorough equipment for future service in a high position.

THE Brake Committee of the Master Car-Builders' Association has decided to hold the second series of tests of freight-train brakes at Burlington, Ia., in May next, instead of April as originally intended. The rules for these tests (which will be found in another column) provide for twelve runs over the course with each train. There are ten brakes entered for the trials, and if all of these should appear, the tests will take between three and four weeks, judging from experience with last summer's trials. This will leave the Committee but scant time to prepare its report to be submitted to the Convention in June. May seemed to be the more acceptable time to all parties concerned, however, and so it was fixed.

More than half the work at the tests will be in the trial of the new brakes, which will then make their appearance as competitors for the first time.

The brakes now entered for the test are the Westinghouse, the American, the Eames, the Rote, the Widdifield & Button, the Ward, the Hanscom, the Carpenter Electric, the Waldumer Electric and the Park Electric brakes.

AN interesting feature in the brake trials, if all the competitors appear, will be the presence of several electric brakes, which will now, for the first time, make their appearance at a public competitive trial in this country. The Park brake has been tried, we believe, but has not been shown in competition with the older forms of brake, The use of electricity for this purpose has many promising features, but its practicability in daily service, under the hard conditions of ordinary freight traffic, has still to be demonstrated.

The Brake Committee deserves thanks for the time and work which its members have given and are still giving to these tests, the most thorough which have ever been made or even attempted in this country.

AN ENGINEERING LIBRARY.

EVERY American engineer who is interested in the literature of his profession, and especially those who, in making investigations, have had occasion to make use of such literature, must have felt the need of a good engineering library. At present, there is no collection of engineering books which approaches, even in a remote degree, to being as complete as it could be made by the expenditure of a comparatively small amount of money. Quite a number of libraries of engineering books have been started, but all of them are still very fragmentary and incomplete. The Astor Library has, perhaps, the largest assortment of such books in the country, but to supply the needs of any profession a library should be controlled by persons who know what those needs are; or, in other words, by those who belong to the profession whose members are to use the books.

The American Society of Civil Engineers has a collection of books, received by donation and otherwise, which has now considerably outgrown the quarters provided for it. It is constantly increasing, whereas the building of the Society, like the raiment of a boy, does not grow. The consequence is that the library is in a state of more or less congestion, which promises to continue until money is forthcoming to extend the quarters now occupied by its owner.

The American Society of Mechanical Engineers has also the nucleus about which it is hoped there will ultimately be an accretion of books sufficient to form some kind of a library, and the Society has for some time past had under consideration measures looking to the foundation of a collection of books for the use of its members.

Some time ago, a move was made simultaneously in the two Societies in the American Institute of Mining Engineers and in the Society of Electrical Engineers to create a "joint library" for the use of those and other kindred organizations. Committees were appointed and several meetings were held, and the matter was discussed at considerable length. It was also proposed at these meetings that there should be a building provided in which some, if not all, the Societies interested in the library could each have rooms suitable for their uses. The members of the joint committee were unanimous that a library and a building for the accommodation of the Societies were very much needed, and the proceedings of the committee meetings consisted chiefly of remarks in which the desirability of the end proposed was emphasized. But, alas, saying and feeling how much a thing is needed does very little to create what is wanted. No definite plan of coöperation among the Societies was proposed. If a building is erected, the title and ownership must be vested in some person or persons authorized and qualified to act in that capacity. If four Societies combine to own property, how shall the title be held? If they undertake to establish a library, how shall it be managed? No very definite scheme was suggested to meet these difficulties, and it now seems very doubtful whether any other action will be taken by the joint committee to accomplish the ends for which it was created.

The need of a good engineering library is as great or greater than ever. All the impressive remarks which were made at the committee meetings on the importance and value of a good library are as true now as they were when they were made. The problem is to devise some practicable scheme of organization for the creation of such a collection of books as is wanted. A general, vague and indefinite scheme will not do—it must be a plan which will indicate the next step which should be taken, and that and successive steps must lead to the desired end. Now, who can devise such a scheme?

It does not seem probable that there would be difficulty in getting money or books for such a library. There are so many men in engineering occupations who are, and others who will be, rich that there will be no lack of means in the hands of those interested in a such a scheme. There can be very little doubt, too, that a considerable number of such persons would be inclined to contribute, either by bequest or otherwise, for the creation of an engineering library, if one was organized on a basis, and its management entrusted to hands which would ensure that money contributed would be wisely expended for the furtherance of the objects for which it was intended. One difficulty is, that a library must have a building to hold it. If this is ever provided, one-half the work is accomplished. It has not yet been announced what plans the trustees of the magnificent bequest of Mr. Tilden, for a public library, have made for carrying out the purpose for which the money was left. It would seem, though, as it would be a proper use of a part of it, if the trustees should, in erecting a building, arrange it so that a portion could be devoted to the reception and care of a technical library of books relating to the useful arts, which would, of course, include engineering. If this were done and the trustees would agree to assume the care of books contributed to this section, the engineering societies could then solicit contributions for the purchase of books relating to their own specialties, with an understanding that the money thus contributed should be expended under the direction of a permanent library committee consisting of members appointed from each Society.

The committee could be instrumental in soliciting contributions for engineering books, either by bequest or donation, and could indicate the deficiencies of the library and the needs of the profession. With such an arrangement more could be accomplished with the Tilden be-

quest and with the contributions for an engineering library, than either would alone. The Tilden trustees would, in effect, say to engineers and others, "we will furnish a suitable place and assume the care of books relating to your occupations, if you will supply the books;" and the joint-library committee would announce that contributions were needed for books in any given department or for special purposes which they might indicate, and that the committee would direct the expenditure either as its own members might think best or in accordance with the instructions of the donors. The committee could solicit and receive contributions, suggest bequests to the living, and take care of what might be bequeathed by the dead. It seems quite certain that a plan of this kind would insure a continuous and rapid growth to a technical library, without any expenditure on the part of the Tilden trustees, excepting that required for the housing and care of the books.

STEEL FOR HEAVY GUNS.

THE discussion on this subject, which was elicited by the paper of Mr. Dorsey, read at the meeting of the United States Naval Institution held in Annapolis in January, has attracted much attention, owing in part to the proposed large appropriations by Congress for the manufacture of ordnance. Mr. Dorsey is a civilian engineer and showed courage, perhaps temerity, in submitting his views for criticism by naval and military experts. His paper may be briefly summarized as follows: "The treacherous and capricious qualities of steel increase with its tensile strength and the size of the piece. Steel of a small size will have greater tensile strength than that of a large size if the work on each is the same. Hard steel is too unreliable to be used in its natural state, in large pieces, for any kind of structural work, and the great improvement reported in the working qualities of hard steel, caused by the oil bath on large pieces, have not been conclusively demonstrated, therefore, hard steel should not be used for the large guns. By the use of many and thin hoops or cylinders of mild steel, properly built up and proportioned, a gun can be made that will be at all times safe, reliable and unfailing. If hard steel, or steel of high tensile strength, in thick hoops, is used, the gun will be more costly and of greater theoretical strength, but practically much weaker, and will fail when least expected and without any apparent cause or reason."

Copies of the paper were sent to the friends and supporters of the author, as well as to other steel manufacturers and ordnance experts who were invited to be present or to communicate their views. The result is a discussion of much interest which has been published in the "Proceedings" of the Institute and occupies 125 pages of the volume.

A number of eminent civilians concur in the views of Mr. Dorsey, but evidences of dissent begin to manifest themselves as soon as we reach the discussion of the paper by expert manufacturers of steel and ordnance. Thus, Mr. Wellman of the Otis Iron & Steel Company says Mr. Dorsey's argument is "that because mild steel has been proved to be the best material for structural purposes and for steam boilers, therefore it is the best for heavy guns. The kind of strain put upon steel boiler-plates and structural material is of an entirely different kind from that to which gun steel is subjected, the former having to withstand nothing but steady loads, while the latter is continually subjected to shocks, and these of the most severe kind. * * * It has been repeatedly proved by many experiments with both kinds of steel that piston rods of steam hammers made of hard steel, and that above 0 50 per cent. in carbon, stand many times longer than soft steel, and that the softer the steel the shorter the life of the rod."

Lieut. Ingersoll, Head of Department of Ordnance and Gunnery, U. S. N. A., called attention to the fact that "in bridge and boiler construction the tensile strength, combined with an assumed factor of safety, limits the load the structure is calculated to stand, and this one quality is always kept in view. With gun-makers, however, the tensile strength is not considered at all in the design of a gun, but the elastic strength and the ductility—or elasticity if you please—of the metal within its elastic limit. Therefore, the *elastic strength* or the ability of a gun to resist permanent deformation, and *not* its *tensile strength* or its ability to resist fracture, is the quantity which limits the safe load with an assumed factor of safety. * * * Simply giving the *tensile strength* of a metal really tells very little about its fitness for gun construction. * * * We seek a metal which has a large percentage of *elastic elongation*, or elongation within the elastic limit, which characteristic aids the metal to resist the vibrating strain to which it is subjected."

Lieut. Ingersoll also called attention to experiments with oil tempering, showing that such experiments as have been made go to show that its effect is undoubtedly felt throughout the mass

Mr. Jas. Morgan, Jr., Chief Engineer of the Cambria Iron and Steel Works, said that the author's remarks as to oil tempering may be taken as an expression of opinion from one somewhat uninformed on the subject, and that the ordnance tests show the cooling effect will penetrate to the center of the largest gun hoops, with very trifling differences in hardness between the interior and outside corner. He also said the carbon or hardness of locomotive and car-tire steel, is not less than approved gun steel. Rails 0.30 to 0.40 carbon, axles 0.30 carbon, and many other things, are by no means mild steel.

Lieut. Austen M. Knight, U. S. N., in charge of the Naval Proving Grounds, Annapolis, said that the author of the paper believes that steel of this tensile strength cannot be made reliable and uniform; that it is and must be treacherous. In this, he differs from nearly every firm in the world which has had experience in the manufacture of steel in large masses.

Generally, it may be said that the experts in the construction of ordnance dissented from the views set forth in Mr. Dorsey's paper, while those who agreed with him had no special knowledge of the subject. The discussion is of very great interest at the present time, but it shows how dangerous it usually is for one who is not an expert on a subject of this kind to undertake to impart instruction to those who are.

A CORRECTION.

ONE of our cotemporaries has good-naturedly called attention to an error in our article on Heating Railroad Cars, in the February number of the JOURNAL. On the assumption that a Baker heater has 56 square feet of heat-

ing surface, it was calculated that twelve cars would have a total of 67.2 square feet, from which it was erroneously deduced that *probably* less than a half of one per cent. of the capacity of the locomotive boiler is required to heat a train of twelve cars. The error consisted in inadvertently taking the heating surface of the boiler at 12,000 instead of 1,200 square feet, and the percentage should have been "probably less than 5 per cent." instead of a half of 1 per cent. It is not asserted that these figures represent, even approximately, the actual proportion of the boiler capacity required to heat a train of cars. They indicate, though—and that is all that was intended—that only a small fraction of the boiler capacity is required to heat cars. Our cotemporary tries to prove, and it is not disputed, that "from 2½ to 3½ per cent. of the total supply of steam is needed for heating." But what does it mean by the following sentence: "The same result, in substance, is reached by remembering that more square feet of grate surface an engine can comfortably burn 80 to 100 pounds of coal per hour, or 1,360 to 1,700 pounds, and computing the horse-power from that at 3 to 4 pounds per hour."

NEW PUBLICATIONS.

"TREATISE ON THE THEORY OF THE CONSTRUCTION OF HELICOIDAL OBLIQUE ARCHES."—*By John L. Culley, C. E.* Van Nostrand's Science Series, No. 87,

THE volume before us treats of a subject which is generally regarded as a kind of bugbear by the constructing engineer. Skew arches, which came into existence, or, at least, into frequent use, with the introduction of railroads, have been and still are avoided in every way possible; but cases occur when no contrivance nor ingenuity can excuse the necessity of an oblique crossing, and a skew bridge then becomes inevitable. The introduction of girders has overcome, in great measure, the difficulties of such cases, and it is safe to say that, in the future, very few oblique crossings will be made on masonry arches. But, here again, occasions will, from time to time, present themselves when, for one reason or another, it is considered preferable to use stone or brick rather than iron or steel, and the engineer or architect should certainly be prepared to meet such emergencies.

In Mr. Culley's little volume, one system—the helicoidal—of designing and constructing such arches is mainly dwelt upon, although some space is allotted to the consideration of the logarithmic method also. The latter we take to be the same as the orthogonal method of the French constructors. Which preceded the other in point of date of invention, we confess we do not know, but one would imagine that the helicoidal grew out of the effort to simplify the logarithmic by substituting straight lines for curves in the development of the soffit. Naturally, the latter is the more perfect and scientific method; there are limitations to the use of the former in the case of full-centered arches, which can, however, be overcome, Mr. Culley tells us, by means of special construction of the wing walls. It would have been useful to explain and illustrate such special construction. He enunciates a perfectly sound principle when he states that, for a considerable degree of obliquity, segmental arches are far preferable to full-centered ones. Indeed, the flatter the segment, the more nearly the helicoidal system approaches mathematical correctness, the limit being reached in the *plate bande*, where the soffit of the natural arch is the same as its development.

In his remarks upon centering for skew arches, Mr. Culley does not enforce the importance of its being particularly solid and well braced. This is absolutely necessary, in order that it may stand the various false strains to which it will be exposed. This adds considerably to the cost, and we may here observe that we cannot consider the comparison which Mr. Culley makes between the cost of skew and right arches as complete. The extra waste in getting out the voussoirs is a comparatively small item. We think a more serious source of increased expense will be found in the fact that the cutting and laying of stones with warped surfaces is a specialty, and not only requires the employment of men drawn from a relatively small class, but demands also more time and care than is called for in straight work.

Mr. Culley appears to us to be somewhat hasty in his sweeping condemnation of echeloned ribs as a means of effecting a skew crossing. Some admirable specimens of bridges constructed upon this principle exist in France, built by engineers of high standing. If securing great strength with the minimum of expenditure be a test of good engineering, then certainly the bridge carrying the Chemin de Fer de l'Ouest over the Chartres highway, built in this way, must be considered as reflecting great credit upon its designer, Monsieur Boucher. We believe this method owes its origin to the recognition of the comparative weakness of skew arches with high rise and great obliquity. In the bridge just mentioned, the span on the square is 9 meters, and the rise 5—a semi-ellipse, in fact, with the minor axis for span. The angle of skew is 36°. How should we design and build a helicoidal arch with these data?

So much for what may be termed "adverse criticism." It is pleasanter to be able to say that Mr. Culley's clever little volume is likely to prove very useful to those who have occasion to qualify themselves in the matter of skew arches. It would be too much to say of it that it clears away all the difficulties of the subject; the fact that the art of properly laying down the lines of such structures cannot be reduced to a general routine, but must vary with almost every particular case, precludes the possibility of doing this by book. But the present volume will be found of great help, and contains much which we do not think can be readily, if at all, found elsewhere. For the rest, we quite agree with Mr. Dobson ("Masonry," Weale's Series, No. 25) that the best way to get a full realization of the principles of the oblique arch is by constructing a model.

It is a pity that the otherwise neat pages of this book should be marred by a number of misprints.

"THE THEORY AND PRACTICE OF SURVEYING."—*Designed for the use of Surveyors and Engineers generally, and especially for the use of students in engineering. By J. B. Johnson, C. E., Professor of Civil Engineering in Washington University, St. Louis, Mo.* New York: John Wiley & Sons, 1886.

THIS octavo volume of 683 pages endeavors to cover the entire field of the science and art of surveying, first, by describing the construction, use and adjustment of all

kinds of instruments; and, secondly, by presenting the methods for the execution of land, topographical, railroad, hydrographical, mining, city and geodetic surveys. Each of these departments, indeed, is a science by itself, to the detailed development of which a volume might be devoted, and the author, in endeavoring to compass them all in a single book, has undertaken a heavy task. In general, however, it may be said that the task has been well performed, and that the book is likely to be a serviceable one to engineers, although much might have been gained by excluding a few of the special topics and devoting the space thus saved to the elaboration of others. This is particularly true in regard to railroad surveying, the chapter on which covers but twelve pages, and which gives but a very general and imperfect description of the methods of railroad location. The same may be said in regard to the subjects of the mean velocity of rivers and the gauging of streams by means of weirs, to which the author devotes part of a chapter. What is presented on these matters is, of course, valuable to those who have no other source of information, but it is possible that a dependence upon this alone might exemplify the maxim that a little knowledge is a dangerous thing.

The first part of the book, 171 pages, is devoted to surveying instruments. The methods for the adjustment of instruments are stated very clearly and satisfactorily, and the explanations given of the reasons for the operations will prove valuable to students, who are too often apt, as the author remarks, to memorize the methods without understanding the *rationale* of the process. We have not been able to find any definition of the term "line of collimation," which should, of course, be clearly understood by the student before attempting the adjustments which relate to it.

The chapters on land and topographical surveying are excellent and thorough. The remarks in regard to the precautions to be taken to ensure precision and in regard to allowable limits of error are suggestive and valuable, and form a distinctive feature of the book. Surveys are not merely to be made and plotted, but they are to be made so as to satisfy certain conditions of precision and economy. The old text-books gave us merely the mathematical methods, leaving the student to learn in the school of experience the degrees of accuracy which should be required in different classes of work, but the modern method, as exemplified by Professor Johnson, is in all respects more advantageous. The use of the steel tape, for instance, is scarcely alluded to by most text-books, although it has long been extensively employed in all classes of work; but the volume before us makes it the main instrument for the measurement of lines, and gives a thorough explanation of the manner in which it may be used to measure a base line with a high degree of precision.

One of the longest chapters in the book is that on geodetic surveying, which attempts to cover not merely the general theory and field work, but also the astronomical operations for the determination of time, azimuth, latitude and longitude. Probably the author has not given sufficient space to these topics to meet the demands of geodetic observers, as large volumes have been written entirely devoted to field astronomy. The adjustment of angles, quadrilaterals and triangulation systems can also be scarcely presented with satisfaction without previous explanation of the method of least squares. For the use of students in engineering schools, however, the chapter seems well adapted as an introduction to the subject. The author's suggestion that the helioscope may be improved by the omission of one of the disks, would probably not stand the test of actual trial unless the operator were an expert of high attainments.

In the computation of earthwork the prismoidal formula is closely followed as should be the case, and a table is given for the deduction of solidities directly from the field notes of cross-sections. The chapter on city surveys, by Mr. William Bounton, City Surveyor of St. Louis, emphasizes the fact that the common methods of land surveying are entirely inedequate in cities, and gives much valuable information in regard to monuments, standards of measure and discrepancies in records. The subject of mine surveying is well treated in the space of 23 pages. On the whole, this volume gives more of the practice of surveying than any other with which we are acquainted, while the theory is also well presented. The arrangement of the work seems better adapted for the use of engineers than for a students' text book, although it will doubtless prove more advantageous for the latter purpose than any other book which attempts to cover all departments of surveying.

"SAFE RAILWAY WORKING."—*A Treatise on Railway Accidents, their Causes and Preventions, with a Description of Modern Appliances and Systems.—By Clement E. Stretton, C. E.* London: Crosby, Lockwood & Co.

The author of this book is the Vice-President and Consulting Engineer of the Amalgamated Society of Railway Servants of England, an association corresponding somewhat with the Brotherhood of Locomotive Engineers in this country, although the two organizations differ a good deal in the classes of persons included in their membership and in the objects aimed at by them. The author also says that "it is his duty to examine, consider, and report upon the circumstances attending every accident, and the new or improved safety appliances necessary to prevent such occurrences in future." How many of the railroad managers and master mechanics would open their eyes if the Brotherhood of Locomotive Engineers should appoint some competent person to represent their organization in a similar way.

In the first chapter Mr. Stretton gives suggestions for safe railway working, some of which would be quite impracticable in this country, and the wisdom of some others would be disputed by managers here.

As an example, his second suggestion is that "all railways ought to be worked on the absolute block system *strictly carried out*, so that no two trains of any kind shall ever be in one section at one time." It will be a long time before this suggestion is adopted on all American roads.

The first chapter is succeeded by the inevitable historical one that most writers seem to think is essential in every technical book. In this case it is a history of permanent way. Its omission would improve the book.

The third chapter is on Railway Signaling and contains a description of the block and interlocking systems. It is very doubtful, though, whether any one unacquainted with these systems, would be able to understand either of them from the descriptions in Mr. Stretton's book. He

has, for years past, been an indefatigable writer for the newspapers, and it seems as though he had taken a collection of desultory articles relating to accidents, and made a book of them.

A chapter is devoted to Brakes, another to the Report and Awards of the Jurors of the Coupling Trials held at the Nine Elms Goods Yard of the London & Southwestern Railway last March.

The last chapter is devoted to Railway Servants and the Law. Mr. Stretton has done some good work in defense of the members of the Amalgamated Society against the improper or unjust administration of the law in cases of accident. He cites numerous cases in which injustice either had been done or was threatened to members of the Society, who were protected by its intervention in their behalf. That railroad employés sometimes need to be defended in this country in similar cases is probably true, although recent events have shown that corporations as often require to be defended from their employés.

Persons interested in railroad operation will find Mr. Stretton's book very interesting and, to some extent, instructive reading, but it belongs to a class of books which leads a reviewer to wonder why the author took so much trouble to make it as good as it is, and then did not make it much better.

BOOKS RECEIVED.

"INDIAN ENGINEERING;" Volume I, Nos. 1, 2 and 3 Published in Calcutta, India; Pat. Doyle, C. E., editor.

"Report of Proceedings of the Nineteenth Annual Convention of the American Railway Master Mechanics' Association."

"Report of the Proceedings of the Twentieth Annual Convention of the Master Car-Builders' Association."

OBITUARY.

WILLIAM WILLARD WILSON, Engineer and Superintendent of the Yonkers (N. Y.) Water Works and City Surveyor, died on February 7, in the 47th year of his age. He was born in New York City, but his parents moving to Havana he was there educated as a civil engineer. Mr. Wilson was appointed City Engineer of Yonkers in 1874, and prepared plans of the water works, on which, after some opposition, the works were finally built. Mr. Wilson was a member of the American Society of Civil Engineers, having joined the Society January 5, 1870.

M. BLAVIER, whose death in Paris recently is announced, was one of the most distinguished French electricians, Chief Inspector of the French telegraph lines, Director at the School of Telegraphy and Vice-President of the International Society of Electricians. M. Blavier was one of the promoters of the Paris Congress, in 1881, where the absolute system of measurement for electrical and magnetic magnitudes was adopted. His books on Telegraphy and on the Absolute System of Measurement are justly considered standard contributions to science. His experimental researches have also been fruitful of important results, and one of the last series of experiments undertaken was in connection with earth currents and was carried out with the assistance of Prof. Mascart.

JUDGE THOMAS RUSSELL, Chairman of the Massachusetts Railroad Commission, died at his residence in Boston, February 9. He was born in Plymouth, Mass., in 1825, graduated from Harvard College and studied law. He was successful at the bar, and when still a young man was appointed Judge of the Superior Court. After his retirement from the Court he entered actively into politics and held several offices, including those of Collector of the Port of Boston and United States Minister to Venezuela.

In June, 1879, Judge Russell was appointed Railroad Commissioner by Governor Talbot, to succeed Mr. Charles Francis Adams, Jr. He was the lawyer member of the Commission and as such did his full share of its work, although his previous training and experience did not enable him to fully replace his predecessor, under whose leadership the Massachusetts Commission attained so high a reputation. Judge Russell was, however, a faithful member of the Board and performed his duties carefully and intelligently. His death was caused by pneumonia.

Contributions.

The Faught Car Chill.

TO THE EDITOR OF THE RAILROAD & ENGINEERING JOURNAL: On page 89 of the February number of your journal the statement is made that, when many years ago I invented an improvement in car-wheel chills, I had mainly in view the prevention of the "disintegration of the inner surface of the chill by sawing its face into many sections." This statement is incorrect; the chill invented by me in 1876 was intended not so much to improve the chill, as to improve the chilling effect on the wheel itself. The chill was called by me at that time "a contracting chill" and acted substantially as such. The product from that chill, exhibited at the Centennial Exhibition was noted for its uniform and superior chill.

LUTHER R. FAUGHT.

PHILADELPHIA, February 16, 1887.

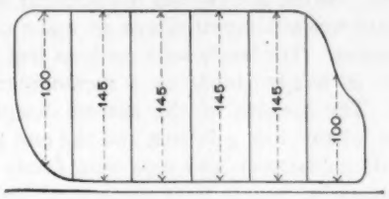
Tractive Power of Locomotives.

EDITOR OF THE RAILROAD AND ENGINEERING JOURNAL: There has been considerable interest taken in the fact that locomotives can pull more than the Pambour formula shows is possible. I believe the following is an incident going to show this to be the case. In 1885, I was connected as master mechanic with the Locomotive Trust & Improvement Company. They had an engine built at the Rhode Island Locomotive Works, having 18 × 24 in. cylinders and 57 in. driving-wheels—the engine being of the ordinary eight-wheel or American type. This engine was fitted with a traction device for throwing a portion of the tender's weight on to the engine. The "pop" valve was set at 160 lbs. In a test on the Union Pacific Railroad, this engine took 680 tons—including engine and tender—from Brookville to Mt. Zion, a distance of 16 miles, in one hour and 18 minutes. This portion of the road is a continuous grade of 70 feet per mile. Unfortunately the engine was not indicated, but with the "pop" valve set at 160 lbs., with the variations below that which would occur, it does not seem probable that the initial cylinder pressure was over 150 lbs., and it is also probable that there was a back pressure of at least 5 lbs. This would make a card as follows, giving an average effective pressure of 130 lbs. per square inch, then

$$\frac{24 \times 18^2 \times 130}{57} = 17{,}734 \text{ lbs.}$$

The resistance due to gravity on a 70-foot hill would

be 26½ lbs. per ton and 680 × 26½ = 18,020 lbs., which would make it seem that the Pambour formula is wrong because the resistance of gravity alone is greater than the pull the engine exerted on the tender draw-bar.



If it be assumed the average effective pressure was 140, which is possible, we have

$$\frac{24 \times 18^2 \times 140}{57} = 19{,}098 \text{ lbs.}$$

Gravity would use 18,020 lbs. of this, leaving but 1,078 lbs. for friction of the train or but $\frac{1078}{680} = 1.58$ lb. per ton, which is much less than has ever been recorded. If, as is usual, 5 lbs. per ton of train for resistance on a level be added to 26½ lbs. for gravity, making 31½ lbs. total for each ton, we have 680 × 31½ = 21,420 lbs. total resistance for the train, which is more than the engine would exert if the mean effective pressure was 150 lbs. per square inch.

FRANK C. SMITH.

[The formula quoted above, does not make its own correctness as obvious as the rule for calculating the tractive power given in Clark's Railway Machinery does. That rule is, "multiply the effective mean pressure per square inch in the cylinder by the area of the piston and by four times its stroke to represent the duplicate action of two cylinders, and divide by the circumference of the driving-wheel. The result is the tractive power at the rails."

There can be no room for questioning the correctness of this rule, which s practically the same as Pambour's. But we agree with our correspondent that locomotives will often pull more than with assumed piston pressures, and the supposed resistance of train calculations will show that they should pull. This is probably due to the fact that the maximum pressure in the cylinders, when an engine is working up to its utmost capacity, is greater than that shown by indicator diagrams which are *not* taken at such times; next, the true rate of gradients and weight of trains is not always known; and third, when rolling stock and track are both in good condition there is reason for believing that the resistance is considerably less than that given in the books. It is to these reasons that the discrepancies between the actual practice and the calculation of our correspondent may, it is thought, be attributed, and not to any error in the rule quoted.—EDITOR RAILROAD AND ENGINEERING JOURNAL.]

Heating Cars.

EDITOR RAILROAD AND ENGINEERING JOURNAL: I have read an article on heating railroad cars in the JOURNAL of February, 1887, with a great deal of interest. It appears to me that this article is in the wrong in advocating stoves. In my opinion, stoves are a relic of barbarism when used for heating cars. If placed under the cars a very slight accident will break them to pieces and probably set fire to the cars. What would become of the stoves for instance, should an accident produce the position shown in Fig. 1 of the article referred to? And what could prevent the cars from being set fire to?

Steam from the locomotive seems to be the *only* safe method. Answering Mr. Depew's objection, I will say that with the Gold system cars will remain comfortable for two hours after the locomotive is detached, and for an hour with the Martin or Sewell systems. Where cars have to stand at the stations as Mr. Depew instances, what is to prevent heating the station building by the same system, deriving heat from stationary boilers which could supply heat to the waiting cars. The coupling question has already been solved by Mr. Martin, who uses no hose.

WATERMAN STONE.

THE GEODETIC WORK IN THE UNITED STATES.

MASON AND DIXON, 1764–1768.

The names of Mason and Dixon suggest to two classes of persons as many distinct ideas, together, in many cases, with a commingling that strangely represents tradition tinged with truth. The clearly defined notions are: (1) Mason and Dixon determined the length of a degree in America by measurement; (2) they located the boundary between Maryland on the one part and Delaware and Pennsylvania on the other. These are facts, but popular belief adds one or both of the following fancies: (*a*) they measured the arc from which they ascertained the degree's length while fixing the boundary; (*b*) the boundary they established between Maryland and Pennsylvania was the northern limit of slavery established by the Missouri Compromise of 1820. The first misconception will be rectified in what follows, in which it will be shown that Mason and Dixon did not mark that portion of the boundary which they measured with sufficient care to use its length for geodetic data; and the latter will be refuted when it is stated that the line agreed to in the Compromise was latitude 36° 30′, while the Maryland-Pennsylvania boundary is latitude 39° 43′ 18″, or 39° 43′ 26.3″, as found by Col. Graham in 1850.

According to the agreement made in 1732, regarding the boundary between Delaware and Maryland, a line was to be run across the peninsula from Cape Henlopen due east and west, then from the middle point of this line another should be run northward in such a manner that it would be tangent to a circle drawn around New Castle with a radius of 12 miles. From this tangent point the line was to be continued due north to a point whose latitude was that of an imaginary point just 15 miles south of the most southern part of Philadelphia. Law suits and other sources of delay followed, so that it was not until 1760 that commissioners were appointed, who ran the line across the peninsula, determined the middle, computed the point of tangency and ran the tangent. As the entire line was through dense forests, it was necessary to cut out sight-lines or vistas, making the work so tedious that three years were consumed in accomplishing the part just mentioned. The proprietors, who resided in London, became so impatient that they decided to send surveyors from England to complete the undertaking, and to verify what had been done. The persons selected were Charles Mason and Jeremiah Dixon. They arrived in Philadel-

phia, Nov. 15, 1763, and began work by erecting a small wooden observatory at the most southern point in that city. Here they observed for latitude, using a sector of 6 feet radius constructed by Bird, which Maskelyne said was the first to have the plumb-line passing over and bisecting a point at the center of the instrument. During the following spring, while testing the lines run by their predecessors, they noticed that the tangent line was almost due north, and the character of the ground such as to make it quite easy to measure the line with the accuracy that would allow the results to be used in ascertaining the length of a degree. Also, that the amplitude could be found by simply observing for latitude at one additional point, having already determined the latitude of the northern end of the arc in fixing the point from which the west line between Pennsylvania and Maryland was to start.

It is probable that Mason and Dixon received their inspiration to perform this geodetic work from Boscovich, whom they may have known in London during his stay there in 1760. Boscovich had been elected a Fellow of the Royal Society, in consideration of his degree measurements in Italy from 1751 to 1753, and Mason and Dixon, while in the swamps of the peninsula, might have seen along the vista in which they were working the coveted way to become, as De Morgan said, a Fellow Really Scientific; at all events, each became an F. R. S., in consequence of this very undertaking.

They represented to Maskelyne, who was then Astronomer Royal, the advantages this line offered for accurate measurement, and indicated their willingness to take charge of the work at the Society's expense. On Oct. 24, 1764, the Council of the Royal Society resolved that the precise measure of a degree of latitude in America, in the neighborhood of Pennsylvania, appears to the Council and to the Astronomer Royal, who was pleased to assist on this occasion, to be a work of great importance, and that the known abilities of Messrs. Mason and Dixon, the excellence of the instruments with which they are furnished, the favorable level of the country and their assistants well practiced in measuring, do all concur in giving good ground for hope that the business may now be executed with greater precision than has ever yet been done, and at a much less charge than the Society can reasonably expect an opportunity of doing hereafter.

"*Resolved*, to employ Messrs. Mason and Dixon in the said admeasurement of a degree of latitude, and to allow them the whole of their demand, being the sum of two hundred pounds sterling for the said work; and also, in case the proprietors of Maryland and Pennsylvania should refuse their stipulated allowance for their passage home, but not otherwise, the further sum of forty pounds, for the said passage." A resolution was adopted requesting Maskelyne to draw up the instructions for their guidance. These were sent together with a brass standard of 5 feet, with which the measuring rods were frequently to be compared, and the difference noted, and also the height of the thermometer at the time.

Work on the Pennsylvania-Maryland boundary was stopped, 15 miles before the terminus was reached, in 1767, by the Indians, who said it was not the wish of the chiefs that a certain war-path should be crossed, so Mason and Dixon returned to Philadelphia, and at once prepared to make the measurement so encouragingly endorsed.

While testing the line they intended to measure it was found that the alignment was practically perfect, leaving nothing to be done but to determine its length and amplitude. The apparatus they devised for measuring they called levels, because they were placed in a level position when in use. As the ground was not perfectly horizontal, the apparatus was so constructed as to make contact on different planes. The levels were each 20 feet in length and 4 feet in height, made in a rectangular form of inch pine. The breadth of the bottom board was 7½ inches, that of the top, 3 inches, and the end pieces, 4½ inches, while the bottoms and tops were firmly strengthened by means of boards fixed to them at right angles. The joints were secured with plates of iron, and the ends plated with brass. They were set level by means of a plumb-line, 3 feet 2 inches long, suspended in the middle, the point of the plumb-bob bisecting a given mark in the bottom; the plumb-line was hung within a tube, so as to be free from the action of the wind. If the frames were true rectangles every point in the ends would be in the same vertical when the top and bottom were horizontal. In case the ground was irregular one end of the level was raised by a "winch and pulley." Just how this was done is not stated. When a level was put in position, a short stake was driven in the ground very near and opposite the plumb-line, in the top of which moved a thin iron plate, about 12 inches long. In both ends of this plate there were points that could be directed toward the intersection of cross lines on the frame.

By bringing these points into line with the intersection, the level could be placed in its former position if moved while making contact. One level was set and marked, the alignment being effected by sighting along the top to the point made by the apparent convergence of the sides of the vista, then another level was placed in front, adjusted and marked, when the rear one would be brought forward, and so on. Record was kept by stretching, in a line parallel to and quite near the levels, a rope equal to 12 times the length of one of them, and the number of rope lengths recorded. The mile-stones placed by the first surveyors also served as checks upon the count.

The levels were frequently compared with the brass standard, provided by the Royal Society, and the difference between the lengths of the two levels and 8 times the standard was noted, together with the temperature at the time of comparing. At the ends of the bottom boards of each level there was attached, in the direction of their length, a piece of brass on which a fine line was drawn a tenth of an inch of the end. The last tenth of an inch of the standard was divided into hundredths so that, by means of a magnifier, the difference between 8 times the length of the standard and the two levels could be quite easily ascertained. The standard temperature was 62° F, that being the temperature previously adopted in comparing, and the coefficient of expansion for brass, .0000108 was taken from Graham's determinations.

Streams were crossed by measuring a short base and putting the distance from a point on one bank to another on the bank opposite, from angles observed with a Hadley quadrant.

The azimuth of the tangent line was found by observing Ursa Major on three evenings to be 3° 43′ 30″.

A B = 434,011.64 ft., referred to brass standard at 62° F. Supposing that *t* is the point in which the great circle passing through B cuts the meridian A M, then regarding A B *t* as a right angle, they computed A *t*. In

THE STRONG LOCOMOTIVE "DUPLE

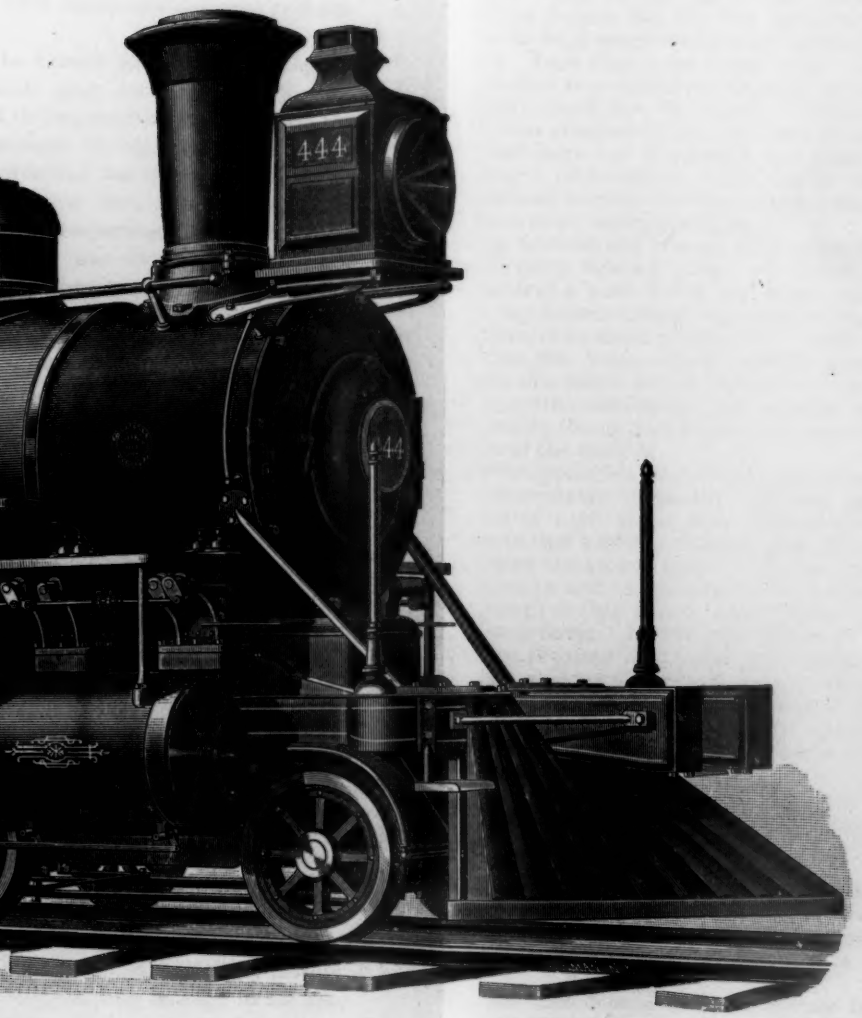
BUILT IN THE SHOPS OF THE LEHIGH VALLEY RAILROAD, AT

ALEXANDER MITCHELL, *Division Superintendent and Master Mechani*

THE STRONG LOCOMOTIVE "DUPLEX."

BUILT IN THE SHOPS OF THE LEHIGH VALLEY RAILROAD, AT WILKESBA

ALEXANDER MITCHELL, *Division Superintendent and Master Mechanic.*



ESBARRE, PA.

doing this they regarded the triangle as plane, thinking that the smallness of the angle at A and the shortness of the sides as compared with the radius of the sphere would not change it greatly from a plane triangle. This gave A *t*, 433,094 ft., and they then subtracted R *t*, the distance of the great circle from the circle of parallel which they found to be 15.8 ft.

The corrected value for A R = 433,078.8 ft.; N P, by measurement, at 62° F. = 78,290.7 ft.; C D, by measurement, at 62° F = 26,608 ft.; D G, by computation (C D M = 86° 32½′, nearly), = 89.7 ft., giving as the distance between the parallels of A and N = 538,067.2 ft.

The amplitude of the arc from difference of zenith distances as measured with the sector referred to was 1° 28′ 45″. The latitude of N was ascertained previously to be 39° 56′ 18.9″, which gives 39° 11′ 56″ as the average latitude, at which point from linear measurement and amplitude 1° = 363,763 ft.

It was assumed that the French foot was to the English foot as 114 to 107, which gave for a degree 56,904.5 toises. The accuracy of this equivalent depends upon the temperature of the standards during comparisons; the toise being iron and the five-foot bar brass, their different rates of expansion would give them different lengths at varying temperatures. The temperature to which all the measurements were reduced was 62° F., but it is not known that this was the temperature of the French and English standards while being compared.

After the completion of the measurement the five-foot bar was again adjusted to the Royal Society standard, when it appeared that the length of the arc was too long by 13 feet. "It is probable that the length of a degree has been taken 10 or 20 feet too short by placing the point C too far to the southward, which would about balance the small correction in question." Just what reasons they had for supposing this is not mentioned. Likewise a new comparison was made, using the *toise de perou*, which gave for a degree, 56,888 toises. There seem to have been two copies of this toise of slightly different lengths, and it may be that the same one was not used for the two comparisons. The latter value is the one most frequently quoted.

The actual value of this work has received various estimates: Maskelyne considered it a valuable addition to the measures of degrees, especially as the level character of the country to the north and south of the line rendered a deflection of the plumb line improbable. Cavendish, on the other hand, suggests that the Allegheny Mountains may have shortened the degree by 60 or 100 toises. Airy thought it accurate enough to be used in determining the figure of the earth, as did also Schubert, Listing and Laplace. Bessel did not embody this arc in his discussion, so its influence is not felt in his resulting constants. A degree in the latitude in which this measurement was prosecuted, according to Bessel's formula, is 56,956 toises, being 51.5 toises longer than Mason and Dixon's first value, and 67 longer than their second—a discrepancy greater than exists between any other northern measured and computed degree according to Bessel. Clarke also omitted this arc in his investigation, his formula gives this degree 467 feet or 73 toises longer than they found it.

If the measurement and amplitude of this arc be trustworthy, it shows that, on the hypothesis that the earth is a solid of revolution, that Bessel's spheroid is more nearly correct than Clarke's, since it gives a smaller discrepancy. But in the work of the U. S. Geodetic Survey it has been found that the use of Clarke's spheroid makes the station error a minimum, from which we can infer that the work of Mason and Dixon had but little merit. Their measurement may have been accurate, throwing the error upon the deflection of the plumb-line.

However, we must wait until we have arcs in the Western Hemisphere good enough to have a voice in determining the figure of the earth before we can definitely decide regarding the character of this, the first geodetic operation in America.

The Speed of War Vessels.

The New York *Herald* says "The most noticeable feature of the Senate bill for the construction of steel cruisers is the high speed which these vessels are expected to develop. Less than four years since 15 knots were gladly accepted as a maximum beyond which profitable naval design could not be urged. Greater speed, it is true, had been attained by our first type of commerce destroyers, but there was a general appreciation that the *Wampanoag's* performance could not be accepted as a useful standard, because she was in essentials not a man-of-war, but a mere racing machine.

"To-day, without any undue public astonishment being excited, effective fighting ships are called for wherein every quarter of a knot below 20 miles pays a penalty which, at our former summit of expectation, would have been prohibitive to ship construction. And, what is more startling yet, the bonus which equally goes to any increase upon this speed proves how great is the correlation between scientific attainment and popular appreciation, and how readily the impossibilities of yesterday become the axioms of the morrow.

"Wherever specialists may differ upon other questions of naval construction, there is a universal agreement as to the value of high speed, this element being deemed equivalent to that vaunted weather-gage of the old days which enabled the swifter ship to choose its range and relative position, and to force or avoid an action.

"The growth of this speed development is, therefore, not without interest. Briefly generalized, it may be said that between 1859 and 1875—that tentative period which led to such wonderful realizations—the highest speed under the most favorable circumstances of large vessels was 14 knots. In the smaller classes of unarmored ships it ranged between 8 and 13, while that attained by fast cruisers was from 15 to 16½ knots.

"In the last year Italian armored vessels of over 13,000 tons displacement accomplished over 18 knots, and cruisers, like the Japanese *Naniwa Kan* and the Italian *Angelo Emo*, have reached 20.

"Torpedo boats, which in 1873 began with 14 knots, have now steamed 25, and at the same time this type has increased so materially in size and importance as to have become, not an accessory, but an essential in naval warfare.

"What has been done abroad the *Herald* believes can be more than attained here, and should the present bill become a law it does not doubt that American inventive genius, profiting by the failures and successes of foreign constructors, will produce a type which will revolutionize naval ship construction everywhere."

The Strong Locomotive "Duplex."

THE large illustration given in this number is from a photograph of the locomotive "Duplex," No. 444, recently completed at the Wilkesbarre shops of the Lehigh Valley Railroad. This locomotive is of the Strong pattern, to which some reference has heretofore been made; it has 20 × 24 inch cylinders and six 62-inch drivers. The

Fig. 1.

M. N. FORNEY'S IMPROVED CAR SEAT.

boiler has two fire-chambers, each consisting of a corrugated steel flue, both being joined at the forward ends in a single combustive chamber.

This engine is now at work running passenger trains over the heavy grades of the Mountain Division of the road. Some account of its working, with a detailed description of the engine, will be given hereafter.

M. N. FORNEY'S CAR SEAT.

THE engravings herewith represent the latest form of an improved car seat designed by Mr. M. N. Forney. Fig. 1 is a perspective view, Fig. 2 a front elevation with a section through the side of the car and window, and Fig. 3 an end view with the seat end removed.

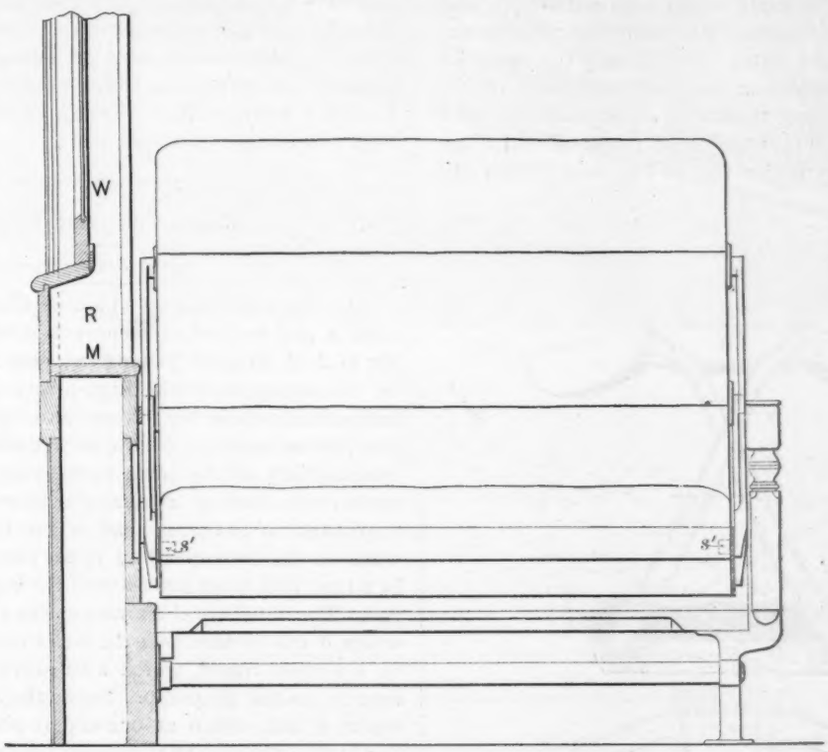


Fig. 2.

The following are the advantages which result from the method of construction shown by the engravings:

1. The backs can be made of any desired height, so as to give ample support for the heads of passengers.

2. While the backs can be as high as required, their lower edges do not come below the tops of the seats, so that there is more room between the front edge of each seat and the back than there is with ordinary seats.

3. The seat-backs have projections which support the lumbar regions of the spine or the "small of the back," where support is most needed to prevent fatigue while in a sitting posture.

4. The seats are made to incline backward, so that the jolting of the car has no tendency to cause their occupants to slide off of them and away from the backs. Very little muscular effort is therefore required to maintain a sitting posture, so that persons can rest or sleep in these seats almost as comfortably as they can lying down. The inclination of the seats is reversed when the backs are turned over.

5. The backs can be reversed in less space than those ordinarily used. The motion is much easier, and there is no tendency to come down with a "bang" when they are tnrned over carelessly.

The mechanism employed to effect these ends is shown clearly in Fig. 3, in which the seat-arm or "end" is removed. The back B' and seat S' are represented by full lines in the position they occupy when the back is turned half-way over. These parts are also shown by dotted lines in their two reversed positions. The back has projections D' and E, E' and D which, when the back is turned over, alternately support the lumbar region or "small of the back" and the head and neck of the occupant of the seat.

The seat-back is reversed from the one position represented by the dotted lines to the other by means of two pairs of crossed links, or arms, $L\,L'$—one pair at each end of the seat. These are connected to the seat-end and side of car by fixed pivots $P\,P'$, and to the seat-back by other pivots, $p\,p'$. The links project below the fixed pivots $P\,P'$, and each of them has a projecting pin or stud $s\,s'$ (shown by dotted lines in Fig. 2.) which support the seat. The seat or cushion-frame has slots $n\,n'$ in each end which receive the pins $s\,s'$. These slots allow for the variation in the distance apart of the pins which occurs when the back is reversed. The action of these links will be readily understood if we follow the movement of the back from the position shown by dotted lines at B, Fig. 3, to the position when it is turned half way over, represented in full lines, and finally to that indicated by dotted lines at B'', when the back is completely reversed. The dotted lines $o\,p\,q$ and $o'\,p'\,q'$ represent the paths in which the pivots $p\,p'$ move when the back is reversed, and $r\,s\,t$, $r'\,s'\,t'$ are the paths which the lower pins or studs $s\,s'$ describe during the same period. It

will be seen that when the back is reversed from the position shown at *B* to *B''* that the pin *s* moves in the arc *t s r*, and *s'* moves from *t'* to *r'*. When the back is in the position *B* the seat is in that shown by the dotted lines at *S''*, and it is then supported on the pins at *t t'*; with the reversal of the back these pins are moved from *t* to *r* and from *t'* to *r'*. The seat then occupies the position shown by the dotted lines *S*. It will be seen that, by reversing the back, the seat is moved horizontally; and its inclination is also reversed, so that in both positions of the back it inclines backward, which adds materially to its comfort. If the seat is not moved horizontally when the back is reversed, more room lengthwise of the car will be required for each seat of a given width and a back of any desired form or inclination. With this mechanism for reversing the backs they can be made of any required height, and, as appears from the illustrations, their lower edges come above the tops of the seats. This leaves the space behind the seat entirely clear, so that with seats of this kind there is more room than with those ordinarily used.

It will also be seen that the fixed pivots *P* and *P'* are located on a line with the top of the seat. With the

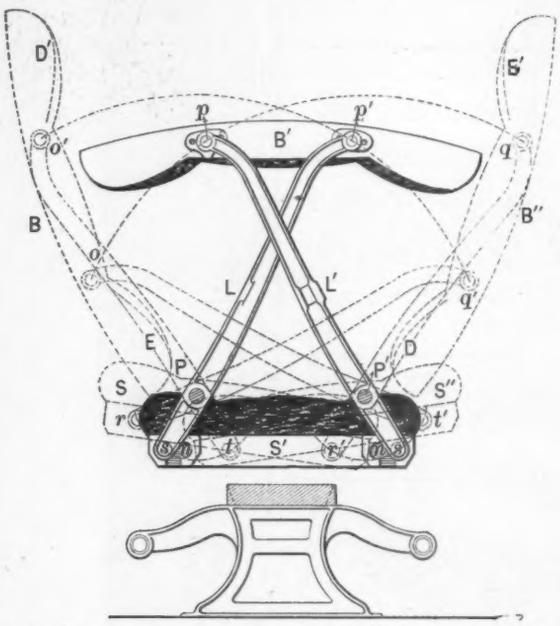


Fig. 3.

ordinary method of reversing backs, the pivot about which it turns must be placed so far above the seat that it elevates the arm-rest at an uncomfortable height, so that the shoulders of passengers are raised up into an uneasy position. The location of the pivots *P P'*, shown in the engravings, permits the arm-rests and window sills to be lowered to any position that will be most conducive to comfort. The fact that the arms of drawing-room car chairs are always made much lower than those of ordinary car seats is evidence that the latter are too high. But if the window sills are lowered so as to be of the most comfortable height for arm-rests, there is danger when they are open that persons will put their arms or feet outside and be hurt, and children standing up in the seats may fall out. For these and other reasons, the method of construction shown in Figs. 1 and 2 has been devised. The window ledge *M*, Fig. 2, has been placed 24 in. above the top of the floor. This is just about the height of a drawing-room car chair arm. Under the window W, a recess or pocket *R* is constructed, which is flush with the outside of the car. This makes the ledge *M* wide enough for a comfortable arm-rest, or it can be used as a shelf to hold books or packages. As shown in Fig. 1, the crossed arms come so low down that they are not in the way of a person occupying the seat, and as the recess or pocket *R* gives sufficient room for the arm of a passenger, he or she can sit close up to the side of the car without discomfort. The result is that in effect, the seat, crosswise of the car, is, with this arrangement, practically lengthened three or four inches. When the windows are up, there is little liability of passengers putting their arms outside of the car, because the recess gives them a more comfortable rest than the window sill above it does. The window recess and this form of seat together, it is thought, will give more room and comfort to passengers than any other arrangement yet devised. Railroad companies or others wishing to use either or both of these devices can address M. N. Forney, 23 Murray Street, New York, for further information.

King's Compound Engine.

(From *Engineering*.)

THE compound engine which we illustrate above represents a new method of construction lately introduced by Mr. H. J. H. King, of Newmarket, near Stroud, Gloucester. In this arrangement the high-pressure cylinder is placed immediately above the low-pressure cylinder, and both of the pistons work on to the same crank-pin through the intermediary of the same connecting-rod. This rod is made in the form of a triangular frame; at one corner it is pivoted to the cross-head of the low-pressure piston, while at the corresponding upper corner it is connected by a long link to an extension of the high-pressure piston-rod. The details of the arrangement are shown in Fig. 2, where it will be seen that the latter piston-rod is cottered to a slotted frame, which also serves to transmit the motion to the air-pump. Inside the slotted frame there works a link, which at one end is pivoted to the frame, and at the other to the triangular connecting-rod. At the apex the connecting-rod works on the crank-pin in the usual way, and transmits to it the power of the two cylinders.

In this particular engine the main valves of the high and low-pressure cylinders are worked by a single eccentric, 1 (see Fig. 2), the rod 2 being taken off at the proper angle to give the right lead to the high-pressure valve. The rocking-arm 3 is centered on the stud 4, and, being of considerable length, the pin 5 moves practically in a straight horizontal line, so that the rocking-arm forms a guide for the high-pressure valve spindle 6.

The expansion valve, which may be automatic or otherwise, consists of a gridiron valve working on the back of the other. The automatic arrangement is shown in this case in dotted lines. The end of the expansion valve spindle is carried by the rocking-arm 7, and the link 8 is moved by the governor. The rod 9 is centered on the pin 10, and 11 is worked by an eccentric, 12, shown in broken lines.

This engine, which we illustrate, is working at Bliss Saw Mills, Chalford, and was formerly a high-pressure engine, with 9 inches cylinder, 20 inches stroke. The fuel pre-

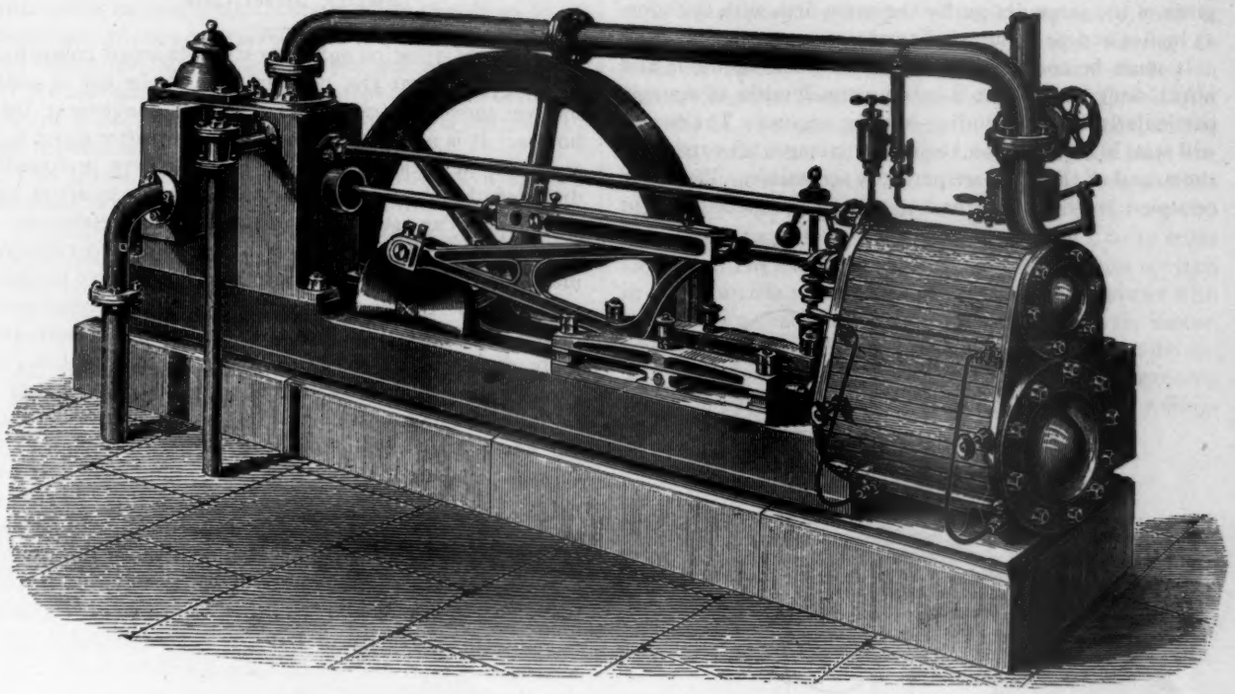
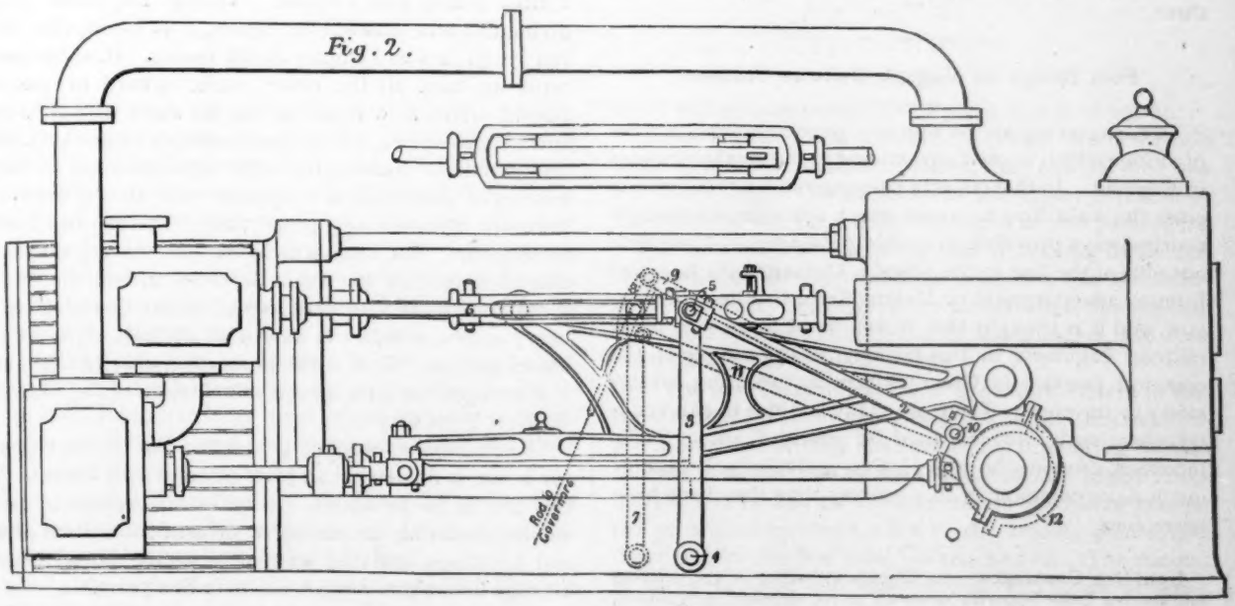


Fig. 1.

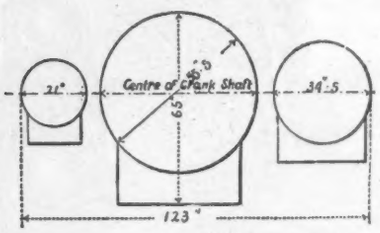


KING'S COMPOUND ENGINE.

viously used was wood, shavings and coal. Now the whole of the coal, except the small quantity required to get up steam, is saved. Mr. King is also making two more engines of the same design for the same firm, with cylinders 13 inches and 24 inches in diameter.

It must be conceded that this is a most ingenious and novel design, and that it offers considerable advantage, particularly in compounding existing engines. The engine will start in any position, the steam passages are extremely short, and all the parts are perfectly accessible. The space occupied is very small, and if the air-pump be brought

Fig. 3.



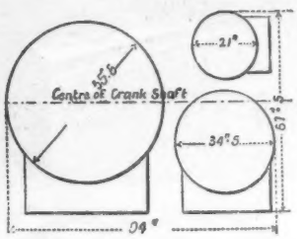


Fig. 4.

nearer the cylinders, does not exceed that of an ordinary high-pressure engine. Figs. 3 and 4 annexed show, as an illustration, the space occupied by a triple-expansion marine engine, first with the cylinders placed as they now usually are; and, second, as they would be if arranged on Mr. King's system, and working on two cranks instead of three.

Foot Bridge for English Railway Stations.

THE engraving on the opposite page represents a form of bridge which is used a great deal at the smaller stations in England. In that country passengers are not allowed to cross the main line, to avoid which a bridge or subway is nearly always provided to enable passengers to cross from one side of the line to the other. The engraving is copied from an advertisement of Messrs. Arrol Brothers, of Glasgow, and it is thought that it will be of interest to many railroad engineers in this country, as an example of the common practice in Great Britain for securing greater safety to travelers. There are many stations in this country where such bridges should be provided, and as traffic increases, crossing bridges of this character will become much more common in this country than they have been heretofore.

Iron Ore Contracts.—In Cleveland, which is the leading market for Lake Superior ores, an active demand is reported, especially for Bessemer ores. Good authorities estimate that contracts have been made for 3,000,000 tons for the season. Naturally, prices are high, and freights by lake are firm also. At Cleveland, specular and magnetic Bessemer ores are quoted at $7 per ton; specular (non-Bessemer) ores, $6; Bessemer hematites, $5.75 @ $6.50, and other hematites $4.50 @ $5.75 per ton.

Selected Articles.

Electric Street Cars.*

THE great question agitating street-railroad companies in this country at the present time is the use of some motive agency more economical and convenient than horses. It is no exaggeration to say that, after about half a century of patient trial, they have become profoundly dissatisfied with animal power and are ready to adopt any system that can establish its claim to their preference.

The struggle for supremacy in this field of occupation may fairly be said to have narrowed itself down to three competitors—the horse, the cable and the electric motor. Steam used directly seems to be viewed with more and more disfavor as the years go by, and has, within city limits, come to be considered very much in the light of a nuisance. The lowest cost of operation per steam motor per day in usual service, quoted authoritatively, is $8.50 to $7. But even if steam were cheap, there are grave objections on the score of noise, smell and dirt. The mere fact that steam locomotives have been in successful use 50 years, but are still denied employment on the streets, tells its own story as to public opinion. To some of us the banishment of steam even from the tracks of elevated roads seems a matter of but a few years. As for gas, soda and compressed-air motors, the writer is not aware that they offer any points of superiority over steam for the specific purpose under discussion.

Coming to horses, we find that, in spite of their universal use and their faithful performance of duty, they inspire a discontent anything but complimentary, yet hardly to be wondered at. The statistics of horse-cars are important and interesting, and deserve our attention as covering the sphere within which the electric motor will operate There are, according to the latest returns available for this year, about 625 street railroads of all kinds in the United States and Canada. Taking 408 horse roads giving full and trustworthy figures, it is found that they run 17,331 cars and employ 85,888 horses. If, at the same ratio, we took all the horse roads, upward of 500, we should arrive at a result of not far short of 25,000 cars and 120,000 horses, a total that probably comes very near the actuality. Taking the other figures, tested by three sources of information, it appears that all the horse-car lines are maintaining a proportion of at least five horses to each car. But that is inclusive, and making a reasonable allowance for the use of different cars for winter and summer, and for idle cars, as well as for doubling up in heavy snows, a result is shown of at least eight to ten horses per car. This is the proportion usually cited, and it is brought out on a special examination of the statistics for New York City.

The conclusion reached is that the cost of horse power for a car is not less than $6.50 per day with horses. To this cost is to be added the necessary expense of large stables, requiring an extensive investment in real estate and buildings, and the cost of replacing horses, whose average life at this work is not over five years.

The cable system is open to two objections, its large first cost and the small part of the power actually used in moving the cars. Figures produced in this paper make

* Abstract of paper read by Mr. T. C. Martin, before the American Institute of Electrical Engineers at its December meeting.

the cost of a cable railroad about $50,000 per mile of single track, putting it out of the question for roads of moderate traffic. Other figures are given from actual experience with cable railroads, which would show that from 68 to 80 per cent. of the power is required to move the machinery and cables, leaving from 32 to 20 per cent. actually utilized for the movement of the rolling stock. At the best, this system is only available where the traffic is sufficient to pay interest on a heavy first cost.

This leaves the field open to the advocates of electric railroads, whose case is fairly stated in this paper.

There are four leading systems of electric motors which are considered in order, as follows:

1st. The third-rail system.

2d. The overhead conductor system.

3d. The conduit system.

4th. The storage or secondary battery system.

1. The third-rail system is represented by two roads in actual operation, one a suburban line, on the Daft system, in Baltimore, and the other the Highland Railroad in Detroit. The Baltimore line is now in its second year of operation; it is a road with comparatively light traffic and has so far been very successful. The cost of power is reported at $4 per car per day, against $6.50 for horses. The road has been so successful as an investment that an extension is now under construction. The largest item in expenses is fuel, coal costing $3.50 per ton.

The Highland road in Detroit is also a line of light traffic; it is a much easier line to operate than the Baltimore road, being free from steep grades and sharp curves. It is three miles long, and has been so successful that plans are arranged for an extension.

The conclusion reached is that the third-rail system must be limited to a low electromotive force, and is best adapted to suburban lines of light traffic.

2. Of the overhead conductor systems the Van Depoele systems form an important group. These roads are now in operation at Detroit, Mich.; Port Huron, Mich.; Windsor, Ont.; Appleton, Wis.; Montgomery, Ala., and Scranton, Pa. In these systems the feeding conductor is suspended by side poles, or, as at Appleton, has double wires corresponding to the track, but immediately above it at a height of 18 or 20 feet. The Appleton road, which has five cars, is run by water-power, having a pair of turbines which will develop 100 horse-power and are now running a 60 horse-power dynamo. The Montgomery road is notable as being a complete city system, having 10 miles of track. The Scranton road which started in January has two features of special interest. One is that in a city of nearly 60,000 people an overhead conductor is allowed; the other is that the line is operated from the electric-light station. The road is 2½ miles long and has 12 grades, most of them 6 per cent. There are in use two heavy cars running at a speed varying from 4 to 15 miles an hour. The current is conveyed by a conductor 0.3 inch in diameter, the rails forming the return. A traveler with rollers and a flexible cable passes the current to the motor, which stands on the front platform in sight of the driver. The electric-light station receives $9 per day for running the 60 horse-power generator, and an increase in rolling-stock will involve very little increase in cost of power.

FOOT BRIDGE FOR RAILROAD STATIONS.

MADE BY ARROL BROTHERS, GLASGOW, SCOTLAND.

Under this head also should be included two new roads built by Mr. Daft at Los Angeles, Cal., one 3½ and one 2½ miles long. On these roads the motor is placed in the center of the car, taking the room of two passengers.

The overhead conductor system is necessarily limited to currents of low electromotive force, but, like the third-rail system, may be employed in places where the expense of a cable system would be out of the question, and even horses could not be made to pay.

3. The first exemplification of a conduit system in this country was given by the Bentley-Knight Electric Railway Company, in 1885, at Cleveland. A working section of their line can now be seen at the Rhode Island Locomotive Works, and as it illustrates in a striking manner the principles involved, a few of the leading points, now described for the first time, are touched on. The conduit is made to resist the heaviest wear and strain of street traffic. The surface opening or slot is only ⅝ inch wide, and the total width of metal at the street surface is but 3 inches. The conduit is kept clean by a broom of peculiar shape suspended from the car. This broom is said to have swept out in a single trip the accumulation from 12 hours' constant snowing. At convenient points catch-

pans with sewer connections receive the sweepings and effect drainage. The two main conductors consist of channel iron connected by expansion joints and lined with a continuous strip of copper of sufficient size to carry the current with but small loss of energy. These conductors are fastened to the side walls of the conduit on insulators of vulcanized wood dipped in white lead. The insulators are strongly set in sockets in the cast-iron supporting yokes. Neither the traffic rails nor the conduit structure form any part of the electrical circuit. To provide for switching, a movable tongue is pivoted at the point of branching, so as to rest on the top of the conduit and to be readily set to close either of the branch slots and direct the contact plow into the other. A corresponding conductor tongue within the conduit is moved at the same time. The contact plow for making connection consists of a flat frame hung from the car by transverse guides, on which it is free to slide the whole width of the car, and extending thence down through the slot of the conduit. It is provided with a swivel joint, so as to adjust itself to all inequalities of road or conduit. This frame carries two flat, steel, insulated conductor cores, to the lower ends of which are attached, by a spring hinge, small contact shoes of chilled cast-iron that slide along in contact with the two main conductors. At the upper ends are flexible connections leading to the motor. This plow can be inserted or withdrawn through the slot at will, the spring hinge allowing the contact shoes to straighten out into line with the conductor cores when the plow is pulled upward and the shoes strike the insulating lining with which the slot irons are provided. By no accident, therefore, can anything be left behind in the conduit to obstruct succeeding cars. The plow guides are hung on transverse axes, and are held in a vertical position by a spring catch that gives way when the plow meets an irresistible obstruction, and hence the plow is automatically thrown completely out of the conduit without injury, being also immediately replaceable. The contact shoes will stand weeks of wear, and cost next to nothing. The frame of the plow has wearing guards of hardened steel wherever it can touch the edge of the conduit slot, and these are also readily renewed. Two plows are used on each contact for the sake of absolute reliability, and to prevent flashing at the contact. The connection between the wheels and motor consists of a system of gear wheels and connecting-rods, the gears being deadened so as to be quite noiseless. The company makes a completely equipped steel-framed truck, with motor, etc., upon which can be placed any car-body. These have a wheel-base of 6 feet, a standard gauge of 4 feet 8½ inches and can be used on curves with a radius of 45 feet. A motor of the Gramme type is used under the car. For long distances, the motors are in series with current constant; for short distances, the motors are put in multiple arc and a new form of resistance is used.

An estimate ot the cost of this system for an existing road in New York City, 3¼ miles long, double track, with very heavy traffic (cars to run 1½ minute headway), maximum grade 3 per cent., and cars running night as well as day, was, for first cost of plant, $213,830; running expenses and interest on cost of plant, $39,320 yearly.

The conduit system of Mr. Wm. Schlesinger has been in use for some months by the Union Electric Company, in Philadelphia. It consists of two conduits, the upper of heavy channel iron for connection, the lower of wood or cement for drainage. To insulate the conductors, an angle iron is riveted to the top flange of the channel iron in such a manner that one of its flanges, pointing downward, parallel to the main side of the channel iron, forms one side of the slot. In the inverted trough thus formed the copper-bar conductors are fastened, the contact being on the under side. Against the conductors, pulling upward, rub or press springs, making a firm, close contact under control by means of a frame holding the springs. In this system the motor is under the car between the axles and geared to them by chains. The motors are intended to work in multiple arc.

It is claimed that in the conduit system the net return of power reaches from 50 to 60 per cent., while the first cost is only about half that of a cable road. A feature of the conduit system is that it is the only one with which high potentials can be employed on the streets. With it, also, the power stations can be placed near ample water supply or where rents are low, or can each be given a section of road to operate.

4. The storage or secondary battery system, though not favorably regarded by some electricians, has been successfully tried. It is stated that this system is to be extensively used at an early date by the North Metropolitan Tramway Company, in London. At Antwerp, in 1885, after six months' competition with four other cars using either steam or compressed air, the Julien electric storage car took the first prize, awarded by a jury of well-known experts. There were in all 23 points of comparison. The Julien car has since been tried in Hamburg, and another has been in operation on the Eighth Avenue line, in New York. It will be admitted that there are advantages in having each car an independent unit, offsetting the disadvantage of carrying the dead-weight of batteries; and that single cars on any road can be taken in hand for change, so that existing rolling-stock can be progressively adapted to the new conditions. This involves a smaller initial outlay and gives opportunity to train the present force in its unfamiliar, though simple duties. Now, regarding first cost, it has been said that two sets for an ordinary street car would cost about $1,500. That seems high. The Julien Company states that the cost of the horses for a car more than covers the initial outlay of the change; the estimate is also made by the company of a total daily running expense of not to exceed $5 per car in cities on heavy traffic. As to life of the batteries, those in the Hamburg-Julien car have been in daily use since April, and they show by test a return of more than 80 per cent. of the power with which they are charged. The car is running on regular daily service. In respect to American storage batteries it may be mentioned that the Electrical Accumulator Company, whose officers have a standing in electrical circles, guarantees two years' life for its new battery and an 80 per cent. return of power. The criticism has been made that ordinarily 20 per cent. of the stored energy is retained on each emission, but, obviously, that is no loss, forming simply 20 per cent. of the succeeding charge.

It is thought that a number of efforts will shortly be made in the direction of using secondary batteries for regular work on street cars, and the result will merit the most careful study. There are, moreover, some ingenious propositions for combining the conduit and storage systems, so as to enjoy the benefits of both. Mr. J. M. Pendleton has described a plan of his of this nature,

and Mr. Elias Ries, of Baltimore, has also carefully elaborated such a system, in which storage plays an important part.

Mr. Martin concludes his paper as follows: "Here, then, illustrated in a variety of ways and by numerous examples, we have a comparison of electricity with other power for propelling street cars, and an idea is given, very imperfectly, of the wide range of choice that electricity itself offers as to methods and means. Much of what has been said has its direct and favorable bearing on elevated railroad traction, as well as on that for underground railways, but the time will not permit me to pursue the subject any further. Many points of discussion arise as to the connection of the car axles with the motor; the use of independent motor cars or of motors on the passenger cars; the types of motors and of conduits or conductors; the potential that is safe under certain conditions; the methods of regulating motor speed; the use of resistances; but all these and others I may leave to you, many of whom are doing practical and creditable work in this field, and who, by thus 'hitching your wagon to a star,' have shown that street cars, if run by electricity, may yet be brought up to the most advanced notions of humanity, comfort, convenience and economy.

"All that remains is to press onward and occupy the preëmpted territory that awaits us. As Emerson says: 'Our duty is plainly not to throw ourselves across the track, not to block improvement, not to sit still till we are stone, but to watch the uprise of successive mornings and to conspire with the new works of new days.' This sentiment may surely be appropriated by modern electricians, who every year put their skill to some severer test, and every year win fresh triumphs. In beginning this street-railroad work, we may count on a large and profitable travel for some time to come through the mere novelty of the thing, but as the art improves it will more and more manifest its right to street-railroad propulsion on the strictest business principles, as well as on every other ground of merit."

Mr. Lucien Arbel's Patent Anti-Dust Ribbed Disk-Wheels.

(Technical Journal of the Alumni of the National College of Art and Trade.)

THE disk-wheels hitherto used, with projecting portions which are either straight or rounded, according to the form of axle, have the great disadvantage, in the case of fast trains, of accumulating considerable dust between the projecting portions and the outer face of the tire, which dust falls into the grease-boxes when the train stops, and heats the axles. Thus it is not unusual, in long runs, for the heated axles to be removed from the cars and others substituted; which always disturbs passengers, especially when the changes are made at night. To avoid this inconvenience and prevent the accidents which might occur, several railroad companies have tried the plan of fastening a thin sheet-iron plate upon the outer face of the wheel, securing the plate to the rim and hub with screw-bolts. But this plan was a total failure, for the plates being insecurely attached to the wheels, were shaken off by the action of centrifugal force and shocks, and, moreover, the continual vibration of the thin sheet-iron plates produced a disagreeable noise.

After long study Mr. Arbel has invented a form of wheel completely satisfying every requirement, the process of manufacture being very simple and well adapted to his plant, so that he can fill large orders promptly.

PROCESS OF MANUFACTURE.

The ribbed disk-wheel differs from the common spoke-wheel merely by the addition of a plate welded to the

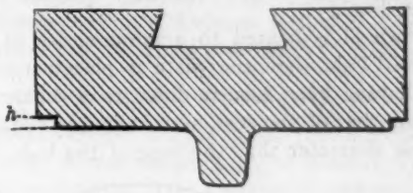


Fig. 1.

outer face of the latter. Hence, it is evident that the manufacture is divided into two distinct processes, which will be described.

The first operation is the forging of the common spoke-wheel, and the second, the welding of the plate to the aforesaid wheel.

First manufacture: Forging the common spoke-wheel.— The process of making a spoke-wheel being well known,

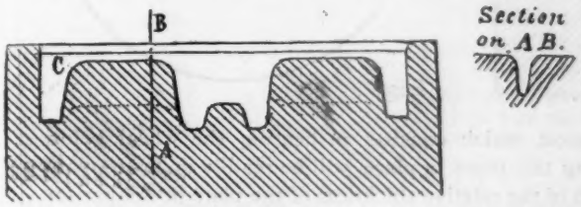


Fig. 2.

it is useless to detail the various steps; we will merely point out the differences between a common spoke wheel and the spoke-wheel which is to become a ribbed disk-wheel. These differences consist: first, in shaping the wheel, which is contained entirely in the lower die, Fig. 1, having simply a plane surface with a depression on the edge, of the depth *h*, about ⅛ inch less than the

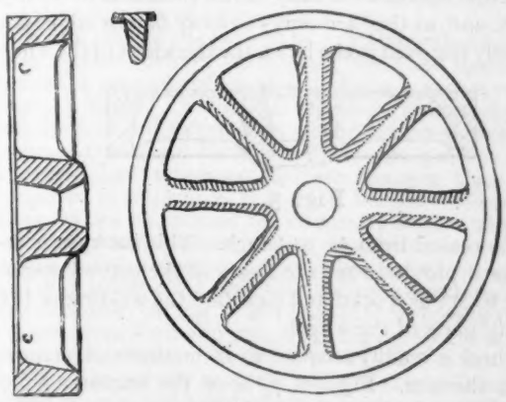


Fig. 3.

thickness of the plate; second, in cutting away the wheel, as shown by the hatched outlines, Fig. 3; finally, in finishing the seat for the plate in a lathe. Thus the sections of the rim, spokes and hub will have the form shown in Fig. 2. It will be noticed that all the sections are rounded on the edges so as to form, even on the projecting portions, depressions which will increase the surface of contact with the plate.

A second heating finishes this wheel, and gives it the form represented in Fig. 3. The wheel is readily cut out, as shown by the hatched outlines, Fig. 3, in a slotting-machine. The seat for the plate is quickly finished in an ordinary lathe.

Second operation: Welding the plate or disk to the spoke wheel.—This operation is very simple, and is performed as follows, the upper die being changed for a plane surface, Fig. 4:

First, the wheel is heated to a temperature of from 1,800° to 2,200° Fah., then the plate is placed upon the seat, Fig. 5, having been turned down to a diameter $\frac{1}{25}$ inch less than that of the seat, and having in the center a hole of less diameter than the bore of the hub. This

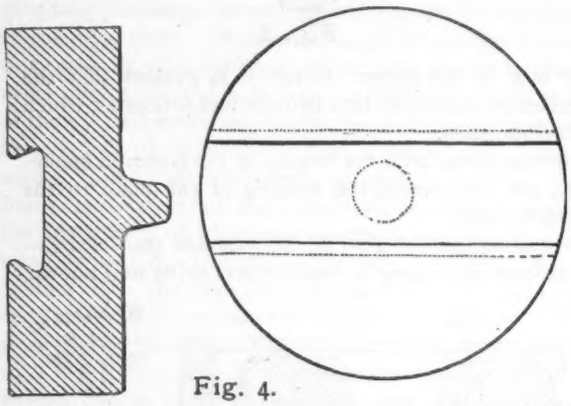


Fig. 4.

operation, which consists in heating the wheel before putting the plate in place, will be readily understood, by reason of the relative thickness of the plate in comparison with the thickness of the other parts of the wheel; consequently, all parts of the wheel simultaneously attain the required temperature. The plate being in position, the wheel is then put into the fire and brought to a welding heat, after which a few blows from a 20-ton ram are sufficient to weld all parts of the plate which are in contact with the wheel.

It is proper to state the projecting portions resulting from the first operation usually have a thickness of from $\frac{1}{8}$ to $\frac{1}{5}$ inch, and, as they are only cut away on the edges and not entirely removed in the lathe, the thickness of the wheel

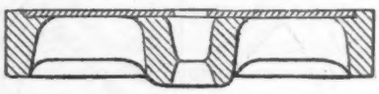


Fig. 5.

is also increased from $\frac{1}{8}$ to $\frac{1}{5}$ inch. This increase is intended as a provision for the losses of the second operation, and to act as a scarf and facilitate the welding of the plate to all parts of the wheel.

This wheel is readily adapted to all methods of connection with the tire. Figs. 6, 7, 8, of the accompanying cuts show the methods most generally employed. The last shows the standard adopted by several railway companies, among others by the Orleans Railway Company, also by the International Sleeping-Car Company. It gives absolute safety in case a tire breaks.

The wheel has the following advantages:

It does not raise dust, and presents no resistance to the air. It is, weight for weight, stronger than the disk-wheel with straight or rounded projections, and stronger, too, than the common spoke wheel, since the effects of

Fig. 6.

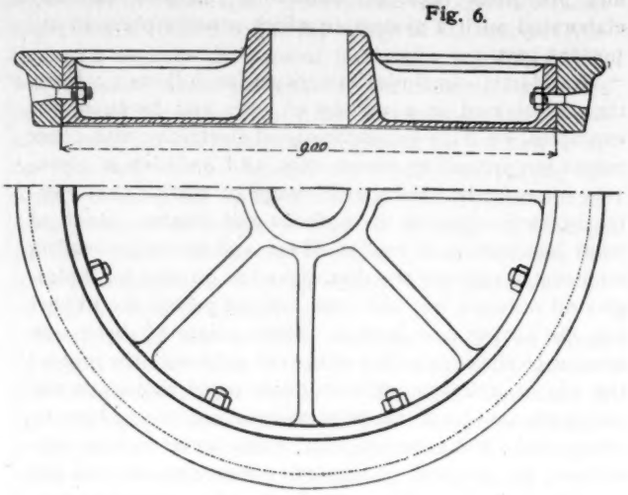


Fig. 7.

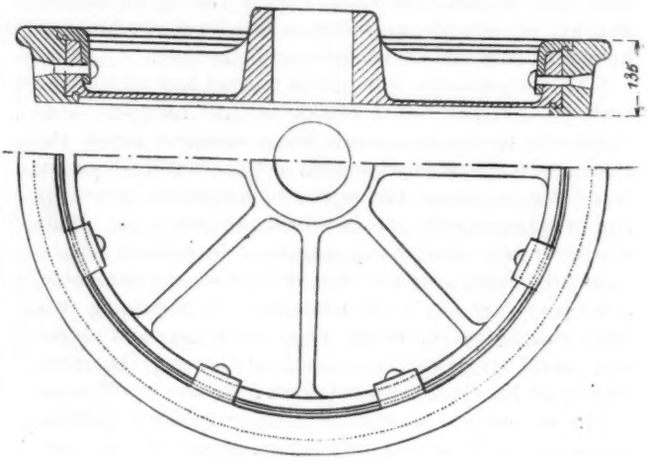
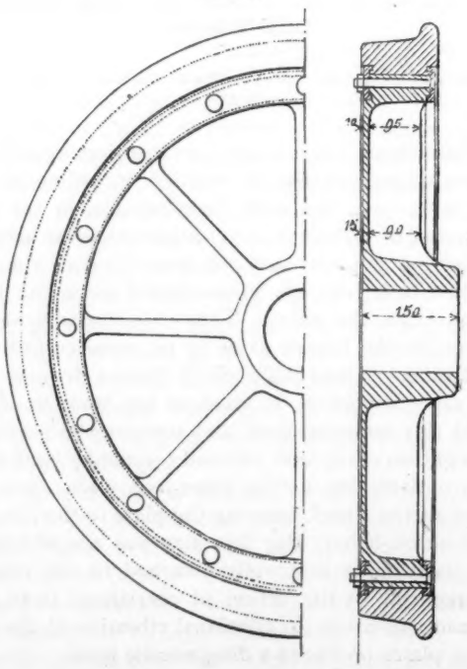


Fig. 8.



torsion and compression upon the spokes are greatly lessened by the resistance of the plate. It presents a much greater resistance and a much greater surface of contact to the strains produced by the tire. It is very easily kept clean. Finally, it is not liable to get out of shape in attaching the tire, as many experiments made by the Orleans Railway Company, in its shops at Paris, have proved; in brief, it has all the good qualities of disk and spoked-wheels, without any of the disadvantages of either.

The table annexed to the plate shows the result of experiments made by Mr. Chéret, Superintendent of the Orleans Railway Company. Tests made by the Eastern

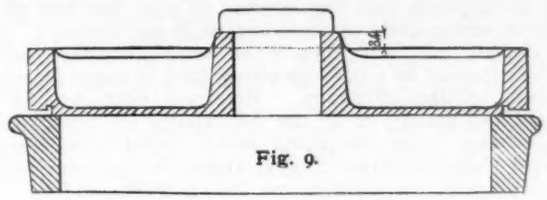
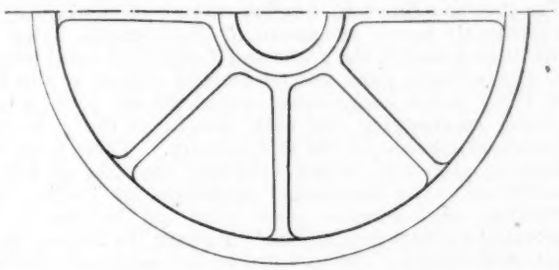


Fig. 9.



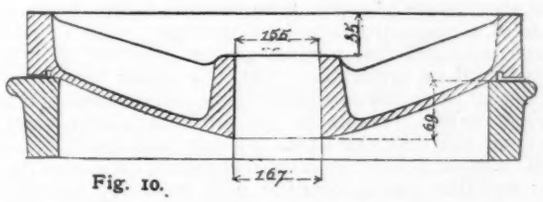
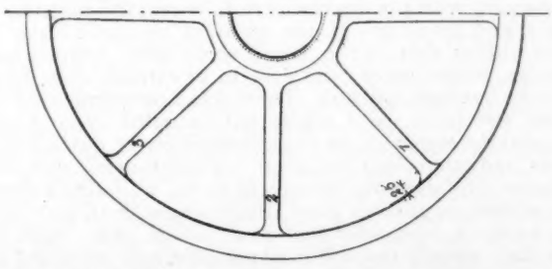


Fig. 10.



Railway Company and the International Sleeping-Car Company have given about the same results, and serve to confirm the qualities and superiority of this invention.

Comparing the results he obtained with this type of wheel, to the results obtained with spoked-wheels and common disk-wheels with straight or rounded projections, it is evident that the ribbed disk-wheel invented by Mr. Arbel is much superior to the wheels heretofore made; and, on account of the success achieved by the Arbel wheel, several railway companies have just determined to adopt it as the standard for all their passenger cars.

Now that the use of continuous brakes is very common, there is a demand for an article capable of thoroughly resisting heavy strains and having absolute rigidity. In these respects, the new wheel, it is claimed, has all the qualities which could be desired.

C. CHÔMIENNE.

CONZON, May 6th, 1885.

(In the cuts all dimensions are in millimeters.)

Methods of fastening the tire to the wheel.

Fig. 6, Eastern Railway. Fig. 7, Austrian-Hungarian State Railway. Fig. 8, Orleans Railway. Fig. 9, wheel before test. Fig. 10, wheel after test.

ARBEL'S PATENT RIBBED DISK-WHEEL.

The wheel was laid in a horizontal position upon a disk-shaped bed. A ram weighing 83,776 pounds, with a drop of 7.9 inches, striking upon a washer placed on the hub of the wheel, gave the results shown in the following table:

Number of blows.	Amount of bending, inches.	Remarks.
0	0	Ram resting upon washer.
5	0.24	
10	0.39	
20	0.71	
30	0.94	
40	1.10	
50	1.26	
60	1.34	
80	1.50	
100	1.62	
120	1.77	
130	1.85	
140	1.93	
150	2.01	Slight crack on spoke No. 1, about 1 inch from the interior of the rim.
160	2.72	

There was no breaking in the weld.

The increase of diameter in the bore of the hub, on the side where the plate was attached, was 0.47 inch, corresponding to an elongation of 7.7 *per cent.* without cracking.

Modern Warships.

MR. W. H. WHITE, Director of Naval Construction and Assistant-Controller of the British Navy, delivered in January at the Mansion-House, London, a lecture on "Modern Warships." The lecture, which was illustrated by diagrams and models, was one of a series given by members of the Company of Shipwrights.

Mr. White opened his lecture by explaining that his object was to place before the meeting facts and figures illustrating the progress of warship building in recent years, and that he should confine his attention almost exclusively to the period between 1859, when the iron-clad reconstruction of the Royal Navy began, and the present year. This period had witnessed greater changes than had taken place in the whole preceding history of warship building. When he entered the admiralty service 28 years ago the too long-deferred steam reconstruction of the Navy was in full swing, the Admiralty, forced on by the action of Napoleon III and his able naval architect, M. Dupuy de Lome, having at last faced the necessity of fitting screw propellers and steam machinery to the largest classes of warships. In the century and a-half preceding this change the progress made in shipbuilding was slow, and vessels remained effective for long periods, the *Victory*, for example, being 40 years old when she fought at Trafalgar. The lead taken by the French in the steam reconstructions and in the constructing of iron-clad frigates such as the *Gloire* was undoubtedly the primary cause of most subsequent activity in warship building. English naval authorities in 1858-59 would, no doubt, have gladly postponed action in the building of armor-clads had they been free to decide. The *Gloire* and her consorts made action imperative, and in May, 1859, the first English sea-going armored ship, the *Warrior*, was ordered. In France, the *Gloire* and nearly all her consorts were really converted Napoleons, in other words,

wood-hulled screw two-deckers, converted into armored frigates. The *Warrior*, on the other hand, was an entirely novel design, of unprecedented length and size, with iron hull and new structural arrangements and fittings. The *Gloire* and *Warrior* and all their successors owed their existence to the terribly destructive effects of shell-fire on unarmored wood-built ships. The primary use of armor-plating was to keep "common shell," with large bursting charges, out of the batteries of ships, and for a long period the struggle between the "attack" and the "defense" in warships was chiefly one between guns and armor. The 4½ inch armor and thick wood-backing on the *Warrior's* sides were practically proof against the heaviest shot, as well as the shell, of the armaments carried when she was designed. In the first stage of the contest, therefore, the defense scored victory, but it was not a lasting one. Gun manufacture rapidly developed and continued to advance, improved kinds of powder were devised, projectiles were produced of a vastly superior kind, and so, step by step, the power of this form of attack had been increased to an astounding extent. Shortly stated, guns had been increased in weight from 4¾ tons to 110 tons, in powder charge from 16 lbs. to 900 lbs., in weight of projectiles from 68 lbs. to 1,800 lbs., in "energy" (measuring the force of the blow struck on impact) from 450 foot-tons to more than 50,000 foot-tons at a range of 1,000 yards. The 68-pounder failed to penetrate the *Warrior* target, with 4½ inches of wrought-iron armor, at close range; the 110-ton gun could penetrate 35 inches of iron at 1,000 yards. There could be no question but that the power of the heaviest guns now carried in warships, as compared with the resistance of the strongest armored defense in existing ships, was greater than it had been at any time since the iron-clad reconstruction began. Nor was the end yet reached, for new projectiles and explosives were being produced which might reasonably be expected to place the attack in an even superior position in relation to the defense. From the very nature of the case, the attack must have greater flexibility and capability of variation of development than the defense. On the other hand, it was but right to note that the defense showed to least advantage under the conditions of peace experiment. These conditions were altogether favorable to the attack; and in actual warfare, as was well known, the gun did not show the same power as at Shoeburyness, Gavres or Spezia. Speaking broadly, from 1859 to 1873, the first half of the period under review, the most notable changes in warships might be said to have resulted from the desire, on the one hand, to carry fewer but heavier guns under armor protection, giving to these guns great horizontal command; and, on the other hand, to increase the defense by thickening armor over the protected portions of ships, obtaining this result by carrying larger relative weights of armor and diminishing the ratio of armored surface to the total surface of the ship's sides. After the old-fashioned broadside system of mounting guns, as in the *Warrior* and *Minotaur*, came the "belt and battery" system of 1863-67, exemplified by the *Bellerophon* and *Hercules*. The *Devastation*, of 1869, marked another step, the introduction of the "breastwork monitor" type, in which sail power was frankly abandoned and twin screws intrusted with the safety of the ship at sea. The *Inflexible*, of 1874, with her armament of four heavy guns in two turrets, with complete command of the horizon, represented in the highest degree the principle of concentration of armor and armament. At this period our clever neighbors across the Channel perceived that while our sailless turret ships of moderate freeboard, with very few but heavy guns, had great fighting power, they also had special weaknesses. So when they set to work on the new French fleet, after the war of 1870, they designed ships in which the few heavy guns were mounted *en barbette* high above water; and associated with these a large number of lighter guns, in positions not protected by armor. These light guns could be fought either simultaneously with the heavy guns or independently, worked and fired with great rapidity, and under many circumstances must clearly be of the greatest value both in action between battle-ships and in repelling torpedo attacks. The construction of these new foreign ships led to the design of the first barbette ships of the *Admiral* class in 1880, and to the laying down of five other similar vessels in 1880-82. In these ships each of the two barbettes was a seperate armored citadel, complete in itself and far distant from the other. In fact, the principle of "distribution" of the main armament, instead of concentration and the association therewith of a powerful secondary armament, was the key of the design. Coming to vessels designed still more recently, it was interesting to note that the *Trafalgar*, designed in 1885, which might be described as a greatly improved and strengthened *Dreadnought*, a vessel which was re-designed in 1872, was rather greater than the largest French ironclads, the *Amiral Baudin* and *Formidable*. The *Trafalgar* and her sister ship, the *Nile*, were surpassed only by the great Italian ships of 13,500 to 14,000 tons. Since displacement or total weight was the naval architect's stock-in-trade, it might be confidently anticipated that the increase in size and cost of our latest armor-clads, as compared with the vessels of 9,000 to 10,000 tons, laid down in the years 1875-84, would be accompanied by a corresponding gain in some feature of their fighting efficiency. Referring next to the debate proceeding as to the desirability or otherwise of a change from compound armor (steel-faced iron) to steel armor for future English ships, the lecturer declined to express an opinion on the subject, adding that France used both steel and compound; while Austria, Germany, Russia and Denmark used compound armor like that now fitted to English ships. Speaking of the enormously heavy armament of line-of-battle ships, he mentioned that in the *Italia* and *Lepanto* the total weight of the barbette, guns and mountings, carried at a height of about 30 feet above water, exceeded 2,000 tons—a load closely approaching the total weight of the first-class line-of-battle ship of the 18th century. There were not wanting advocates of the view that the risks of failure incidental to the mechanical appliances for loading and working our monster guns were too serious to be accepted, and that the guns had outgrown the necessities of the naval service. They pointed to the comparatively long time occupied in loading a very heavy gun, to the unavoidable uncertainty of naval gunnery, and to the enormous value of a single discharge, which might mean a "miss." They considered that a much greater number of lighter guns would be preferable. On the other side, it was urged that in active service so many circumstances made against the effectiveness of gun-fire, that a large margin of power was desirable; that a single successful shot or shell from the heavier guns would produce enormous damage; and that the association of a powerful secondary armament with the heavier guns fully met the case. Having stated both sides of the question he would leave it, only adding that in the latest ships, both English and foreign, while heavy guns were to be carried, they were not the heaviest available. There was a remarkable movement, now in its early stages, but undoubtedly destined to great development, in the construction of quick-firing guns, and mountings for them. A quick-firing gun was capable of delivering from eight to ten well-aimed shots per minute, or possibly more. Beginning with a 6-pounder, to which a 3-pounder was soon added, this class of gun had already reached a 40-pounder, and promised to embrace still larger calibers. Such rapidity of fire, combined with accuracy, range, penetrative power and shell-fire, would undoubtedly prove of enormous value, and could not fail to have an effect on both the armaments and the protection of ships. In some cases attempts had already been made to give protection against the 6-pounder, which could perforate 22¾ inch steel plates at 500 yards; this protection was, however, quite inadequate to resist the fire of the 40-pounder; and so there seemed to be a possibility that another chapter might be opened in the duel between guns and armor. Directing attention to the influence exerted upon modern war-ships by the introduction of the locomotive torpedo, he showed that it had not merely influenced the armaments, structures and equipments of all ships, but had led to the construction of a flotilla of swift vessels, fitted for its use, ranging from boats of 12 or 13 tons displacement and 15 knots speed up to the *Polyphemus* of 2,640

tons and 18 knots speed. The discovery of the *minimum* size of swift torpedo vessels or torpedo boat destroyers, really capable of independent sea service with a fleet, was now engaging attention in all navies. In France the first attempts were made in the *Bombe* class of 18 knots and 320 tons designed in 1883. Here the *Grasshopper* class were designed early in 1885, and the first completed vessel, the *Rattlesnake*, was now commencing her speed trials. These vessels were of 450 tons and estimated to steam about 19 knots an hour. Messrs. Thomson, of Clydebank, had just completed another example of the class intermediate in size between the *Bombe* and the *Grasshopper*, and said to have attained the very high speed of 22½ knots on trial in smooth water. Experience at sea with these vessels would be of immense value to future designs. Submarine attacks by means of diving boats, capable of being propelled at the surface or under water, had been much before the public of late, several such vessels having been built and tried. In the past very many experiments had been made with this class, and the conditions of the designs had been most carefully studied. To gain certain obvious advantages in these under-water attacks very considerable risks must be run; and in the actual operations with such vessels, difficulties of a very formidable nature would have to be overcome before anything approaching certainty in delivering an attack on an enemy could be insured. Everyone would watch with interest the further trials of the vessels with which experiments were now being made. After a reference to the great development during the last four or five years in the construction of swift "protected" cruisers, the lecturer directed attention to certain important matters common to all types of warships, and largely affecting their efficiency as well as their cost. A warship, he explained, was minutely subdivided into a very great number of water-tight compartments in order to gain increased safety against under-water attacks. It was not at all uncommon to find 80 to 100 separate compartments in the hold space of a large ship. All the internal space was appropriated to, and more or less elaborately fitted for, specific purposes. Except the coal bunkers there was practically no space without special fittings for particular portions of armament or equipment. There were no spaces corresponding to the cargo holds of merchant vessels, and frequently it was very difficult to find suitable and available space even for necessary stores, owing to the great demands for accommodation of guns, torpedoes, ammunition, etc. All these compartments had to be drained, ventilated and made accessible. Water-tight doors, sluice valves, drain pipes, suctions, ventilating trunks and fans, voice tubes, telegraphs, electrical circuits for gun and torpedo work as well as for internal lighting had to be provided for. Wherever a steam or exhaust pipe or any gearing passed through a water-tight bulkhead or platform the joint had to be made water-tight. Valves of all kinds, automatic and worked by gearing, had to be multiplied in order that the water-tight subdivision might really be maintained. In a large armored ship it was not uncommon to find more than 100 tons weight devoted to ventilation only, although the ventilation trunks were made of the thinnest sheet-iron or steel. In such a ship, excluding the steam pumps, as much as 80 to 90 tons weight might be absorbed in fitting up the drainage and pumping appliances with their necessary valves and gearing. To work in such weights of material was necessarily a cause of very great expense from which there was no escape, as the fittings could not be simplified with due regard to their efficiency and the preservation of the all-important subdivision. Another very noticeable feature in modern warships was the extended use of mechanical appliances as substitutes for manual labor. In this respect merchant ships doubtless led warships; but in recent years there had been a great and growing tendency to use steam and hydraulic power. In a first-class armored ship of the most modern type there were as many as 76 auxiliary steam and hydraulic engines. From the foregoing statements it would be obvious that the task of designing and building modern warships would be one of great difficulty, even if it were possible to fix beforehand all the conditions to be fulfilled in armament and equipment. Since the iron-clad reconstruction began, however, no such fixity in design, especially for the larger classes of ships, had been obtained. The progress in guns, torpedoes, equipment, materials of construction, propelling apparatus, etc., had been rapid and continuous; and there was a great desire to embody these improvements in vessels still incomplete at the date of their introduction. Of course these additions and alterations meant greater cost, and generally greater weight. In some ships where the construction had extended over six or seven years, changes had been made which, in the aggregate, involved additions of no less than 400 to 500 tons, as compared with the original design. The case of the *Inflexible* was taken as an example. Every naval architect would infinitely prefer to be able to complete the ships for which he was to be responsible in strict accordance with the first design; and in vessels of the smaller classes, occupying less than two years in completing for sea, this desire might be realized. But with the larger classes of warships, of which the construction spread over three or four years, even when money was fully available, the case was different. Improvements were made in armament or equipment, which could be introduced if some additional weight and cost were admitted. The gunnery officer wished to introduce some new type of gun or some heavier charge for a gun, and this addition involved weight and cost. The torpedo officer and the electrician saw their way to improvements also, and the marine engineer desired some greater latitude than was originally allowed, so that he might produce a substantial increase of power and a higher speed. Resistance to these appeals was possible, of course, but very difficult, and he was scarcely sanguine enough to anticipate that in the future there would be no recurrence of difficulties similar to those experienced in the past. Moreover, this matter did not stop with the first completion of a warship at sea. Changes, additions and re-armament were the rule during the whole period of her career. For instance, in the building of the *Warrior*, about 200 tons weight of additions were accepted; and in the 14 years 1861-75 no less than 400 tons more weight were added to the hull, armament and equipment. From the first commission of the *Bellerophon* in 1867 to the last commission in 1886, when she received an entirely new armament of breech-loading guns, over 800 tons additional weight had gone into her. The *Invincible* class had also received on board large additions of weight, involving an increase in draught of water of more than a foot. Cases such as these might be multiplied in foreign as well as in English ships. Adverting to the question of speed, which, he said, was admitted to be of primary importance for all classes of ships, he showed how great had been the improvement in this respect in recent years. Fourteen knots an hour on the measured mile was almost a standard speed for large ships from 1859 to 1875. In the smaller classes of unarmored vessels speeds commonly ranged from eight to 13 knots; and the swiftest cruisers, designed to meet the American *Wampanoag* class, had speeds of 15 to 16½ knots. At the present time the Italian iron-clads of over 13,800 tons displacement had attained speeds of 18 knots per hour; and in the Royal Navy armored vessels of 8,000 to 10,000 tons had speeds of 16½ to 17 knots. Cruisers had speeds of 18 to 20 knots, and small torpedo craft of 19 to 25 knots. But still higher speeds were demanded, and would no doubt be attained. It was the fashion to deny the performances of warships, and to speak of their measured-mile trials as mere *tours de force*, never more to be repeated. To this he would reply that, as between all classes of warships, British or foreign, the measured-mile trial in smooth water was a perfectly fair and complete test of performance. It was confessedly not representative of ordinary practice. The best of coals and stoking were secured, calm weather was selected, the trials were not long continued and everything was in first-rate order. But all these precautions were necessary to secure that uniformity of practice which could alone make the trials absolutely fair and comparable between ship and ship. No one imagined that these measured-mile conditions would be reproduced on service, and the "sea speeds" of all warships were always estimated on

different assumptions. Experience had shown that about two-thirds of the *maximum* power realized with natural draught on the measured mile might be continuously developed under service conditions, and for as long a period as the coal would last; and it had been ascertained by actual trial that the average speed maintained in long-distance steaming in fair weather approximated fairly to that obtained on the smooth-water trials with two-thirds the *maximum* power. The difference between the *maximum* measured mile and *maximum* sea speed of warships of course varied in different classes of ships and for different *maximum* speeds. Roughly speaking, a knot to two knots would be an outside allowance off the measured-mile speed of most of the warships afloat. Familiarity with steamship performance was apt to blunt the perception of the really marvelous results attained. For his part he often felt with Agur—that "the way of a ship in the midst of the sea" was beyond full comprehension. When it was realized that a vessel weighing 10,000 tons could be propelled over a distance of nine knots in an hour by the combustion of less than one ton of coal—the ten-thousandth part of her own weight—it must be admitted that that result was marvelous. Examining next the question of cost, he pointed out that the first cost of a 100-gun line-of-battle ship at the beginning of the century was about £65,000 to £70,000, armament and ordinance stores being excluded, while now the *Trafalgar* and *Nile*, designed in 1885, were estimated at £860,000 each. Adding the value of guns, ammunition and stores, it might be said that the captain of the *Trafalgar* had the responsibility of navigating and fighting a machine representing a million sterling. The estimated value of the largest French iron-clad was from £600,000 to £650,000, and of the Russian from £700,000 to £750,000. In the *Inflexible* the armor-plating alone cost £170,000, the propelling machinery £126,000, the hydraulic gun mountings and auxiliary engines of various kinds £55,000. These three items alone would have produced five first-rates of Nelson's time. The cost of the completed ship represents 12 first-rates of 1800, seven of 1840, and three and a-half of 1859. For the same sum of money there could now be produced four powerful protected cruisers, steaming 20 knots an hour—six knots faster than the *Inflexible*—and carrying gu s capable of piercing 20 inches of wrought iron at 1,000 yards; or a fleet of 30 to 40 swift torpedo craft of various sizes, steaming 20 to 25 knots an hour. Who was to decide what was the best investment of a million sterling, when such different appropriations were possible? The growth of cost ran through the various classes of modern fleets. To obtain a sloop-of-war of modern type, carrying six or eight guns, costs little less than did the 100-gun three-decker of 1800. To build and equip a torpedo boat of the first class costs nearly as much as a sailing frigate of 50 guns in Nelson's time. Large as had been the sums annually spent on shipbuilding dui ing the last quarter of a century, they had not been large enough in proportion to the number and cost of the new ships in hand to permit of rapid construction. This financial limitation, or want of funds in relation to work incomplete, had sadly hampered and hindered progress and completion. Lengthening out the time over which a ship had been on hand, it had indirectly added to the cost, and had given time for the numerous alterations and additions to which he had referred. The Royal Navy was now very strong in armored ships, as was testified in no measured terms by the recent French official reports, and in the financial year about to begin this portion of the fleet available for service would be immensely strengthened by the completion of a large number of new swift ships.

But foreign navies without exception were making strenuous efforts to strengthen the classes of swift protected cruisers and torpedo craft, and, with our world-wide Empire and enormous commercial and shipping interests, this movement abroad compelled action here. For many reasons this development of the swift cruiser classes was to be welcomed. Such vessels were admirably adapted to the characteristics of the British sailor, and would give scope for fresh displays of that mingled audacity and skill which had become a tradition in the service since the time when the small but swift-sailing, handy vessels of the English fleet made havoc with the huge but unwieldy vessels of the Spanish Armada. (Cheers.) With reference to the possible use of mercantile auxiliaries in time of war, he said that he heartily sympathized with all that had been done in the last ten years to encourage methods of construction and subdivision which would better fit these vessels to receive an armament of guns and to be capable of fighting. He believed that in many ways these armed vessels would be of immense value to the country in time of war; but he did not concur in the opinion that they could be treated as substitutes for regular warships, and that the Navy could be reduced in numbers because these auxiliaries might be available, for there were radical and unavoidable differences in structure, protection, machinery and steering gear, as well as handiness and capability of using their armaments, between such vessels and regular-built fighting ships. Merchant ships, in point of handiness, did not and need not approach warships; but for fighting purposes handiness was a quality scarcely less essential than speed. In this connection, he might be allowed to point out how great were the demands made upon the intelligence, skill and courage of the officers and men who had to navigate and fight the warships of these days. How great was the difference between the acquirements necessary for naval officers of the present time and those which sufficed in Nelson's time! Every additional appliance and precaution introduced by the designer, every auxiliary machine, every new weapon added to the responsibility of those who had to care for and use them. Modern naval officers required an acquaintance with scientific and practical gunnery, hydraulic machinery, electric apparatus and torpedo management in addition to the mastery of their primary duties as sailors. Of course there was a necessity for specialization in this knowledge; no one man could be expected to have an exhaustive knowledge of every branch. The gunnery officer was a specialist for guns and gun mountings; the torpedo officer for torpedoes and electric appliances; the engineer officer for machinery of all kinds, and all the multifarious mechanical appliances fitted in a modern ship. Working together under a common head, these officers had never failed, and would never fail, to perform successfully their onerous and increasingly difficult duties. Nor had they, while adding to the range of their knowledge and professional culture, lost the resource, dash and daring for which the service had always been famed. On all occasions, and under the most varied circumstances, they had proved in recent years that this was the simple truth. Every one there would have in mind the never-to-be-forgotten story of the rescue of Sir Charles Wilson and his comrades by the gallant chairman and his sailors, who proved themselves equally at home on the march and in the battles of the desert as they did when running the gauntlet of the batteries on the Nile or "mending the boiler" under fire. (Cheers.) In conclusion, he desired to say that he had purposely avoided anything of a controversial nature, and refrained from attempts to assign individual credit for the many and great improvements which had marked the iron-clad period. His wish had been to indicate in general terms the character and scope of recent changes, and to illustrate the difficulties that had been overcome as well as the results attained.

The Thornycroft Torpedo Boats.

(From *The London Times.*)

LAST week No. 60 first-class torpedo boat arrived at Portsmouth from Chiswick, and, as this vessel is the last of the 25 which Messrs. Thornycroft have had in hand for the Admiralty, it may not be out of place to give a short description of these vessels and of the results which were obtained from them on their official trials. The vessels in question form a moiety of 50 boats ordered by their Lordships, 20 out of the remaining 25 being ordered from Messrs. Yarrow & Co., and five from Messrs. White, of Cowes. The dimensions of the Thornycroft boats are: length over all, 127 ft. 6 in.; beam 12 ft. 6 in.; draught of water with the specified load of 11.56 tons on board, 1 ft. 9 in. forward and 6 ft. aft; stipulated speed on measured

mile, 19 knots. The design was the outcome of the joint labors of a committee of naval officers and the builders, the much-abused snout, of which, with its attendant cascade, so much has been heard, being adopted partly to reduce the weight forward, and partly to secure the breakwater advantages which were found so valuable on a similar vessel, the *Childers*, on her voyage to Australia.

With a view to securing great manœuvering power the system of double rudders patented by Mr. Thornycroft was introduced. These rudders are placed one on either side of the propeller and are curved to a radius a little larger than that of the propeller, so that the propeller practically works in a tube with the bottom half cut away, the result being that when the rudders are put over the whole of the stream from the propeller is diverted sideways; and as there is no dead wood to resist side motion the vessel is turned with great rapidity, and this whether the vessel is going ahead or astern. Curiously enough, in some instances the time of turning the circle is less when going astern than when going ahead. The hull, which is built of Siemens-Martin steel, is divided into a large number of compartments by means of bulkheads and half-bulkheads, so that if the skin should be perforated the quantity of water entering at any one place is limited to the volume of the injured compartment, and these volumes are kept sufficiently small not only to prevent the boat sinking, but to allow of her being navigated while in this disabled condition. Steam ejectors are provided, so that if the hole is small or temporarily stopped the compartment may be rapidly cleared of water and the vessel restored to her former efficiency. The accommodation for the crew, as is usual in torpedo boats, is forward in the torpedo room, and that for the officers is aft, the intermediate space being occupied by the machinery. Steam stearing gear capable of being used by hand is fitted in all the boats, so that not only are the rudders put over with great rapidity, but, as very little manual labor is required, the steersman is enabled to devote the whole of his attention to the actual navigation of the vessel. The machinery is of the type used in torpedo boats, and consists of a pair of compound engines, capable of developing from 700 to 750 indicated horse power, and a locomotive boiler. All the pumps, with the exception of the circulating pump, are worked off the main engines, an arrangement which reduces very considerably the work of the engineers in looking after the engines.

The first five of these vessels were intended to be armed as torpedo vessels, but the remaining 20 were to be armed with quick-firing machine guns and to be used as torpedo boat destroyers. This intention, however, was so far modified that all the vessels were fitted with torpedo gear as the normal armament, but arrangements were made so that, if desired, the torpedo tubes could be removed and the quick-firing guns substituted. Stated briefly, a torpedo tube is simply a gun for ejecting locomotive torpedoes, the ejecting medium hitherto being usually compressed air, but now, and in the case of the boats under notice, gunpowder. The *modus operandi* of loading one of these tubes and discharging the torpedo is as follows:—First, the torpedo, with its "business end" duly filled with gun cotton and its air reservoir charged with compressed air, is placed in the tube with the end of the horizontal rudder frame pressing against the retaining catch; then the small silken bag containing pebble powder is placed in a pocket inside the door of the tube and the door closed and secured. A second cartridge, brass-cased, containing finer powder and capable of being discharged by electricity, is then inserted in a piece of mechanism on the outside of the door, which serves the double purpose of retaining the brass cartridge while being fired and of serving as an ejector subsequently. A heavy weight on the end of a lever at the side of the tube is then raised and retained in the raised position by means of a catch which may be released by an electro-magnet, and a forked appliance, to which the wires from the battery are attached, is inserted in the firing cartridge. The tube is now ready for firing, and all that is necessary to discharge the torpedo is to press a button so as to make contact between the two wires. The first result of this operation is to release the catch holding the weight, which, falling, pulls back the retaining catch, then makes contact with the wires leading to the firing cartridge and so explodes the powder. The torpedo is then blown out of the tube, the air valve in the torpedo being opened as it passes along the tube by means of a tripper in the top of the tube. The noise of the discharge is no louder than would be made by clapping the hands sharply together with the palms a little hollow. Each of the boats under notice is fitted with five of these tubes, one being fixed in the bow and four revolving in pairs round each of the two conning towers. Each pair of revolving tubes is so arranged that when making a passage the tubes may be stowed on stands parallel to the center line of the vessel. When cleared for action they are fixed so as to have an angle of 40 deg. between them, and in this condition may be revolved freely round the conning towers. If, then, the tubes on the forward tower were fixed with the after one abeam, and those on the after tower with the center line between the two tubes abeam, it would be possible to fire one torpedo ahead, one 40 deg. before the beam, one 20 deg. before the beam, one abeam and one 20 deg. abaft the beam. The whole of the five torpedoes could thus be discharged at an enemy's vessel one after the other, the torpedo boat making a curve and discharging each tube as it came to bear on the enemy. Or, if running between two ships of the enemy, she could divide her favors by fixing the tubes so as to bear on either beam. In addition to the torpedo armament, each vessel was fitted for carrying three Nordenfelt guns and a powerful electric search light. The first vessel, No. 25, was ordered as a trial vessel and was fitted out complete by the contractors, the torpedo gear for the other vessels not being ordered till that on her had been subjected to an exhaustive trial. With a view to expediting delivery, the orders for the torpedo gear of the remaining vessels were divided, Messrs. Thornycroft supplying ten sets in addition to the first, Messrs. Maudslay, Sons & Field ten sets and Messrs. Penn four sets.

The speed trials were conducted partly on the Thames at the measured mile in the Lower Hope, partly at Stokes Bay, and although, owing to structural additions and other causes, a much greater load was carried than was specified in the contract, in some cases over 16 tons being carried instead of the specified load of 11.56 tons, the speed was always considerably above the contract speed, in one case 21.66 knots being obtained with a load of nearly 14 tons on board. The average speed of the whole of the 25 boats on the measured mile was 20.39 knots, or 1.39 knots above the contract speed. As might have been expected, the results of the circle trials were also satisfactory, the average time of turning being 85 sec. when going ahead and 87 sec. when going astern. Further improvements, however, may be expected in this direction in subsequent boats, as, owing to the heavy deck load, it was not considered advisable to use the full power of the steering apparatus.

A Locomotive Floating Dock.

(By a Correspondent of *The London Times*.)

NEARLY sixteen years ago the late Lord Hampton, then Sir John Packington, said, "Nobody could contribute a more valuable addition to naval contrivances than to invent a really efficient floating dock, and not only a floating dock, but a dock which when afloat may go to any part of the world." This idea lay dormant for a long time, but has within the last year or so been revived, seriously considered, and is now in a fair way of being carried into effect. Messrs. Rennie, the well-known marine engineers, have devised a navigable floating dock, on an entirely new principle, the designs for which have been most favorably received by the Admiralty. The swift cruisers that naval men are so continuously crying out for would soon cease to be swift if some means for frequently cleaning their copperless bottoms were not provided, and no contrivance appears likely to be so efficacious for this purpose as a dock which could be at the

disposal of a fleet, or division of a fleet, on almost any given part of a station, supposing always that the dock is capable of rendering the services expected of it. Everybody knows that all docks, whether fixed or floating, require considerable pumping power as a matter of course. The one striking original feature in Rennie's design is that this very pumping power is used to propel the dock from place to place when a change of quarters is necessary, and also to careen the dock for purposes of examination, cleansing or repairs. The method of propulsion to be employed is the hydraulic arrangement which, *pace* Sir George Elliot, was not a brilliant success in the *Waterwitch*, but which will be quite sufficient to give the locomotive dock a speed of about six knots, while the advantage of making one set of machinery do the work both of propelling and pumping is obvious. The plans and estimates that have been got out are, in the first instance, for a dock capable of taking in a ship of the *Arethusa* or *Phæton* type, say 300 ft. long, 46 ft. beam, 20 ft. draught and 4,000 tons displacement. Such a dock will have to be 350 ft. long, 96 ft. outside and 60 ft. inside width with a total height of 35 ft., and would be available for use in any harbor of six fathoms depth. Its cost is put down for hull (steel), machinery, capstans, cranes, etc., as £105,000. This does not include anchors and chain cables, as these are always supplied by the Admiralty. The time required for construction would not exceed twelve months. A word as to the careening of the dock. This is effected by utilizing the pumping machinery for filling the water-ballast chambers on either side. The engines would then be stopped and all made secure for careening, when the sluice valves on the side to be raised out of water would be opened, and the dock would gradually heel over so as to expose the under-water part up to the keel. When one side is done the same operation can be performed for the other side. Of course it goes without saying that all the necessary calculations as to stability, strength of materials and horse-power have been most carefully made. It would certainly seem, should this dock fulfil the expectations of those competent to judge, that a great want is in a fair way of being supplied, and it is to be hoped no time will be lost in making the experiment. Such a dock would be most suitably and conveniently berthed at a coaling station, whence at need it could proceed wherever there was sufficient water and shelter.

A New Steamer for the Australian "Orient" Line.

A NEW steamer, the *Ormuz*, has just been completed, and is described as follows in the *London Times:* "She is the latest addition to the Orient Line and the largest vessel that has ever entered the port of London. One naturally examines the arrangements of the *Ormuz* under the branch of safety in relation to the catastrophe which befell the *Oregon*. The *Ormuz* has ten compartments which can be made water-tight by the closing of iron doors, and it will be remembered that the *Oregon* could have been steamed into shallow water and perhaps saved if those on board had succeeded in closing a single door between the furnaces and the injured coal bunker. Every one of the doors on the *Ormuz* can be closed by powerful screws worked from the main deck, and at the spot where they are worked is an index showing exactly in what position the door is. Not only so, but in the case of the doors in the neighborhood of the engine-room, where instantaneous action may be necessary, the removal of a small iron peg is all that is needed to permit the door to fall of its own weight. The door being sharpened at the bottom it will sever any obstacle, such as coal, that may be in its way, and it is not probable that anything less easily cut will be there. The means by which the doors are closed from the main deck consists of a worm-wheel on the end of a rod working on a rack the whole length of the door. This worm-wheel is pressed into the teeth of the rack by a bar which is held across the top of the doorway by a staple and pin. As soon as the pin is removed the bar ceases to press the worm-wheel into the rack, and the door falls with irresistible force. This is the plan adopted in the case of all the doors connected with the engine and boiler compartments. In cases where it is necessary the door should slide from left to right the closing is done on the main deck only. Passengers on the *Ormuz* will be able themselves to see where these doors can be closed. In each case the apparatus is covered by a brass disc, about the size of a dinner-plate let into the floor, as, for instance, one of them is to be seen on the entrance to the drawing-room. Side by side with these are other screw rods for closing the ventilators and so prevent them from becoming aqueducts in case of a compartment being filled. It is impossible to say what combination of circumstances may arise to render these arrangements abortive, but nothing has yet been imagined that is not provided for in this respect. Similarly, on the decks above the water-line, iron doors are provided to isolate fire if it should break out.

In the course of her trials she made nearly 18 knots on the measured mile, but her passage round to London was much interrupted by fog, and the trip affords no sound criterion as to her speed. Her engines are the largest triple-expansion yet made, the diameters of the cylinders being 46 in., 73 in. and 112 in., respectively. With an indicated horse-power of upwards of 8,000, the propeller at full speed made 70 revolutions. The pitch of the screw is 29 ft. for each revolution—that is to say, if the screw-worm were bored into a deal board it would travel 29 ft. with each revolution, and in one minute of 70 revolutions it should progress 2,030 ft., or nearly two-fifths of a mile. This a properly set screw propeller actually does with a discount of from 6 to 12 per cent. only consequent upon the failure of the water to maintain an absolutely solid resistance. The vessel is 465 ft. long, 37 ft. deep and 52 ft. across at the broadest point. It is, however, impossible from casual inspection to state where that broadest point is, because the lines of the vessel are exceptionally fine and there is not a place upon her side that can be said to be flat. Her buoyancy and steadiness will be a matter of extreme satisfaction to the diffident traveler."

The Hooghly Cantilever Bridge.

THE *Indian Engineer*, published in Calcutta, gives the following interesting description of the railroad bridge lately completed over the Hooghly River, a stream that has for many years remained unbridged owing to the many obstacles to be overcome. This bridge was constructed from the designs of Mr. Bradford Leslie, Agent and Engineer-in-Chief of the East Indian Railway.

"The bridge, which is 1,200 feet in length, consists of three bowstring girders of mild steel and is constructed to carry a double line of railway 5 feet 6 inches gauge, the distance of main girders from center to center being 30 feet 8 inches.

"The central girder, which is 360 feet long and 52 feet high at the center, rests upon two piers 120 feet 6 inches centers thus forming a double cantilever, upon the extremities of which the ends of the two shore spans rest solid.

"The piers consist of masonry built inside steel caissons 66 feet long and 25 feet wide, with semi-circular ends, which were sunk to a distance of 100 feet below mean sea level or 120 feet below high water.

"The caissons which were built in 27 rings, 4 feet deep, were sunk to a depth of 108 feet, at which level an excellent foundation of hard yellow clay was obtained, but as the top of the caissons were then below high-water mark the pier was carried up a further 16 feet in solid masonry. Upon this were placed the steel standards, measuring 55 feet by 20 feet, upon which the girder is supported.

"The clear headway from the underside of the bottom boom to high-water mark is 33½ feet, and the height of rail level above mean sea level is 58½ feet.

"The approximate weight of the cantilever is 1,500 tons, and it is constructed with 12 bays of 30 feet each. The bottom boom, which is of box section, is composed of two web plates 3 feet 6 inches deep, the inner being ¾ inch thick throughout, while the outer varies, the maximum thickness being 1 inch. The bottom plates are 4 feet 8 inches wide and of varying thickness from ½ inch

to 1 inch, and the inner and outer strips range from 13 inches by ¼ inch to 27 inches by 1 inch thick. The angle irons are 6×6×¾ to 1 inch thick. The top boom is of similar dimensions, with the exception that the top plate attains a maximum thickness of 1 1/8 inch.

"The ties and struts are formed with angle-irons and plates, the former being mainly composed of plates with strong cover-plates at the joints, while the latter are of lattice construction and by an ingenious disposition of material are rendered of great strength. In section they are square, having double angle-irons back to back at each corner; on two sides web plates are riveted between the two angle-irons, and on the other two sides the plates are riveted to their backs, the whole being stiffened by angle and flat-iron diagonal bracing.

"At a height of 18 feet above rail level the cross bracing commences, which is carried up to the top boom of the girder, the upper and lower members being connected by diagonal bracing. The cross bracing, which is 2 feet 6 inches deep, consists of web plates having outside longitudinal angle-irons and an internal bracing of angle-irons bent to form a rectangular section. The diagonal bracing between the upper and lower cross bracing is formed of channel-iron bars.

"Where the cantilever rests upon the piers, additional raking side struts have been put in extending to a height of nearly 40 feet. These struts are of similar construction to those first described, and measure 4 feet 6 inches by 3 feet 3 inches in cross section, the angle-irons being 6×6×¾ and the bracing 4×4×½ inch.

"The roadway is carried upon cross-girders 30 feet apart and 3 feet 6 inches deep, between which run the four girders carrying the rails. The flooring consists of ⅝ inch steel plates secured to Z irons.

"The cantilever has been built with a camber of 6 inches from the piers to the ends, the portion between the piers being level. At each end of the cantilever a seating has been prepared for the ends of the shore spans to rest upon, and the latter have a bearing of 2 feet 6 inches in length. These girders are 420 feet long each and of similar construction to the cantilever, though, of course, of somewhat lighter section.

"The depth of the girder and dimensions of the top and bottom booms are identical with those of the cantilever, and the thickness of the plates and angles is as follows. In the top booms the web plates are 3 feet 6 inches deep, varying in thickness from ½ inch to 1 3/8 inch. The angle-irons are 6×6×¾, and the thickness of the top plate, which is 4 feet 8 inches wide, varies from ⅜ inch at the ends to 1 3/8 inch at the center. It is strengthened by inner and outer strips 13 inches and 1 foot 7½ inches wide respectively, whose thickness at the center is ½ inch each. Tee-irons are riveted to the outside web-plates to impart additional strength.

"The bottom boom is of similar section, but the tee-iron runner is left out, and the bottom plate measures 1 inch thick at the center; the inner and outer strips, which are both of the same width as those in the bottom boom of the cantilever (13 inches), are each ¾ inch thick.

"The struts are formed of 6-inch angle-iron verticals with 3-inch bracing. The ties are formed of flat bars as in the cantilever, and a channel bar riveted to both ties and struts traverses the whole length of the girder.

"The cross-bracing and wind-ties in the shore girders are much simpler than in the case of the cantilever, and, instead of commencing at a uniform height of 18 feet above rail level, are simply placed between the top booms of the two main girders. The weight of the shore spans is slightly above 1,000 tons each. At the river ends of the girders, a bearing is provided to rest upon those previously mentioned at the ends of the cantilever, and the junction is strengthened by plates riveted to both girders. At the shore ends pendulum bearings are provided, consisting of massive castings 13 feet high and 10 feet by 6 feet on base. These castings are **A** shaped, and near the top—which is bossed out to receive it—passes a steel pin some 15 inches in diameter, extending a few inches beyond each side of the casting, which is here two feet across. On these overhanging ends are keyed two steel links, 10 feet long by 2 feet wide, bored at their lower extremities to receive another similar pin which, in its turn, protrudes beyond the links and receives the weight of the girder by means of cast plates, bolted on either side of the latter, which are turned to a bearing and accurately fit upon the steel pin. As the links are free to move in either direction, any expansion or contraction is at once taken up.

"The abutments upon which the shore spans rest are of brickwork, and on the Hooghly side have been carried down to the yellow clay upon which the central piers rest; while on the Naihati side the clay was not reached, and the abutments rest upon a bed of gray sand.

"On the Hooghly side a brick viaduct, 2,000 feet long, was found necessary on account of the numerous buildings that would be interfered with by an embankment. The span of the arches in the viaduct is 30 feet, and instead of being turned upon wooden centers in the ordinary manner, wrought-iron trusses were made to the curve of the arch and rapidly put into place by means of a portable crane traveling upon a line of rails laid across the arch. These centers, on account of their portability, were found of great advantage, and the rapidity with which this portion of the work was constructed is no doubt due to their use.

"The Naihati viaduct is but 425 feet long and the arches of small span. Both of these viaducts were subjected to immense stresses during the time the shore spans were being built up and launched, and it was considered necessary to strut the arches and brick up a larger opening, over which a bridge is now in course of construction. It is satisfactory to learn that the viaducts showed no signs of weakness during the process of girder-building, and no settlement has taken place.

"As we have indicated, the shore spans were built up upon the viaducts from iron work prepared in England, fitted together and marked before sending out. The cantilever was built in the position it now occupies, a substantial staging being erected between the two piers. The length beyond the piers was simply extended as it was built up, and the advantage that this method possesses over that of building up on shore and floating out to site is too obvious to call for further notice."

Desiccated Sewage.

THE following description of a process of solidifying sewage is taken from the *London Times*: "The works are situated close to the Walthamstow sewage works and farm, and consist of a timber building, two stories high. On the ground floor is the driving power, consisting of a 12-horse engine and boiler; part of the desiccating apparatus is also on this floor, but the treatment of the sewage sludge commences on the upper floor. Here is a tank into which the sewage sludge is pumped after it has been chemically treated and deprived of its supernatant water by Mr. Jerram's arrangements in the adjacent sewage works. The tank will contain about 400 gallons of sludge, which is fed into the water-extracting machine through a 6-inch pipe, and the supply is regulated by a sluice valve.

"The machine, which is about 24 feet in length and 8 feet in width, consists first of a large sludge-vat, in which are two hollow, perforated, metal cylinders, 12 inches diameter, and covered with fine wire gauze having 6,400 meshes per square inch. These cylinders revolve against brushes, which keep the meshes of the wire gauze clear. By means of a pump a partial vacuum is created in these cylinders, and the result is that about 60 per cent. of the moisture contained in the sludge is extracted at this point. From this tank the sludge is delivered by a sluice valve on to an endless traveling web of wire gauze of the same mesh as that on the cylinders, the web being as wide as the machine—namely, 8 feet. This web is supported by brass rollers placed at intervals, and passes under two rollers and over two of Körting's exhausters, which remove

another 10 per cent. of the moisture. The sludge has now assumed the consistency of a thick paste, and in this condition it is passed between five pairs of rollers furnished with iron scrapers. From the last pair of rollers the semi-dried sludge falls into a hopper, whence it is fed into a disintegrating cage on the lower floor, and in which it is finally disintegrated and dried by a blast of warm air, leaving only about 5 per cent. of moisture in it. The solid particles of the sewage now assume the form of a coarse powder, which falls through the wire meshes of the disintegrator on to the head of an Archimedean screw running in a long trough, and by which means the powdered manure is delivered into a pit, whence it is packed in bags for the market. The continuity and efficiency of Mr. Astrop's system were satisfactorily demonstrated to those present, and it was stated that the resulting powder possesses a high manurial value. The process is certainly simple and effective, and if the commercial results of the use of the manure prove successful—and there appears to be no reason why they should not—the process would seem to offer a satisfactory solution of the sewage question under certain conditions."

The New York Boundary Survey.

THE report of the Regent's Boundary Commission upon the New York and Pennsylvania boundary not only announces the conclusion of an important work, but presents a complete account of it, and of the history leading up to it, from the time of the earliest royal grants. Of the octavo volume of 490 pages containing it, some 460 pages are occupied with the final report of the surveyor, Major H. Wadsworth Clarke, of Syracuse, and its interesting appendices.

It was in 1786 and 1787 that the Commissioners of the two States ran the line, as accurately as it could then be done, along the 42d parallel from the Delaware River to Lake Erie. A preliminary reconnoissance having shown that this line never did perfectly coincide with the parallel named, but certainly varied from it, sometimes to the extent of a thousand feet, and, moreover, that a large number of the old monuments were missing, so that the exact recovery of the old line at all points would be very difficult if not impracticable, the question arose, whether it would not be better to resurvey with the best modern skill and instruments of precision the parallel of latitude originally intended to be the boundary, and to establish as a boundary in future, without regard to the remaining monuments of a hundred years ago, the geodetic line thus determined. The Pennsylvania Commissioners at first favored the idea of a new line, but fortunately better counsels prevailed; the views of the New York Commission were adopted, and the important considerations of long-established usage and cadastral boundaries were not sacrificed to the fanciful advantage of astronomical accuracy. The Joint Commission set itself to work to recover the old line, from the Delaware to the corner with the western meridian boundary—a distance of 226.84 miles. The number of milestones on the old line was 224, the average distance between them being about 1 per cent. over a mile. Of these 224 milestones, 122 were found in place and undisputed; 37 were found removed from their places and in various stages of dilapidation; and the other 65 were entirely missing. Of other monuments known to have been on the line, 11 were found in place, though some of them were broken; 6 were out of place or missing —and doubtless others might be included in this last category, only that the memory as well as the material of them has disappeared. It was evidently high time to restore landmarks.

Mr. C. M. Gere, the surveyor on the part of Pennsylvania, having retired from active field work on account of ill-health, a high compliment was paid to Major Clarke by the request of the Pennsylvania Commissioners that he would act for both States; and the latter half of the work was conducted by him. To him, also, we owe the present exhaustive and valuable report, which, although dated in December, 1885, and transmitted to the Senate with the report of the Commissioners, April 22, 1886, has but recently been published as Senate Document No. 71, of 1886.

In addition to the work on the parallel boundary, the meridian boundary on the west (about 18⅞ miles in length) was restored, 51 monuments being set upon it. Of all this work, Major Clarke gives a complete, clear and interesting account, tracing, moreover, the history of all negotiations, transactions and surveys affecting either boundary. In the appendix are numerous curious data and documents, among which we notice a careful *résume* of the boundaries given to New York and Pennsylvania on ancient maps, interesting accounts of the "Massachusetts claim," the "Connecticut claim in Pennsylvania," the "Connecticut Gore in New York" and the "Erie Triangle," and finally complete maps of the restored boundary showing locations of new monuments throughout. We do not hesitate to say that Major Clarke, who has skillfully restored and set so many monuments, has, in this final report, added a crowning one to the list—a monument to his own fame. He deserves to be, and we trust he will be, as long remembered as Mason and Dixon.—*Engineering and Mining Journal.*

Reorganizing the Signal Service.

Science, in a recent number, says: "The death of General Hazen, Chief Signal Officer of the Army, marks the close of the second period of the development of our weather bureau. During the ten years from 1870 to 1880, while the bureau was under the direction of its first Chief, General Myer, the labor expended upon it was given in greatest part to its organization. Stations had to be selected and their instrumental outfit determined; the time and kind of observations had to be decided upon, and observers instructed in their duties; the methods of reduction of data to practical form for use on a weather-map had to be adapted to the needs of a larger area than was ever before brought under the control of a single weather office. Apart from the almost exclusively military constitution of the service during these years, its most marked characteristics in contrast with the European weather services were the large sums of public money devoted to its support, the system of tri-daily observations, and the absolute control exercised over all telegraphic lines in the collection of reports, in virtue of the law of 1866. Its maps were thus prepared more frequently and more promptly than weather maps are abroad, and were admired all over the world.

"General Hazen took charge of a highly developed service, and turned his efforts in two directions that to most persons appeared quite contradictory. He insisted on the need of military organization, and, at the same time, introduced numerous and important improvements that had nothing military about them. But during his administration, public discussion was frequently turned to the advisability of 'civilizing' the weather bureau, for its work was not as successful as was desired. A committee of the National Academy of Sciences reported in favor of the change, the then Secretary of War urged it, and a joint congressional commission recommended it, three members of the commission advising a gradual, and three an immediate, transfer from military to civil authority. Popular opinion very generally supported these recommendations, and the chief objections to them came from the military element of the service itself. All the official declarations of the service maintained to the last that a military organization was essential to success in weather prediction. It might be forcibly contended, on the basis of published statements in the annual reports, that the service had, for its first object, the availability of its entire force in case of war, were it not that its whole public work refuted this theory. The real work of the service is the announcement of the approach and force of storms throughout the United States for the benefit of agriculture and commerce in time of peace.

"The people at large have taken a great interest in the Government weather bureau, and desire to see its work continued and its predictions improved. They would be glad to see an extension of scientific study in its offices, for on such study all its chances of better success depend. The opening of the third period in its history will, therefore, be watched with the deepest interest. The needs of the service must be thoroughly and deliberately considered. Immediate action, resulting in the appointment either of a military chief or of a civil director, would be deprecated on all sides, for the interests involved are too great to be endangered by hasty decision. Moreover, there is a very general desire, on the part of meteorologists and of scientists generally throughout the country, that they should at least be heard in the matter before decision is reached, so that whatever plan of future organization is adopted shall be based on full and open discussion. Deliberate action and authorized opportunity for consideration of scientific as well as of military methods are, therefore, of the first importance. It should be the earnest effort of all who have watched the development of the signal service thus far to secure these guaranties of its further progress."

Compound Engines.

MR. V. BORRIES, it will be remembered, says *The Engineer*, is associated with Mr. Worsdell in compound engine work. The following statement from his pen as to the advantages and *rationale* of compounding is taken from *Glaser's Annalen*, published in Berlin:

"The advantage of compound working may be stated as follows: In the ordinary locomotive, with slide valves and narrow ports, it is not very desirable to attempt more than three to four-fold expansion, and the steam is passed off at a pretty high temperature, which is utilized somewhat in the second cylinder of the compound machine. Furthermore, the shell of the cylinder naturally takes the mean temperature of the steam passing through it; and as the temperature of the expanded steam falls below this it absorbs, before passing into the stack, a certain amount of heat from the cylinder shell which has to be replaced from the entering steam. This operation in a compound machine takes place in the low-pressure cylinder only, since the heat absorbed by the steam from the other cylinder is utilized in the low-pressure one. The steam lost in the clearance spaces and in the leakage around the piston of the high-pressure cylinder is also utilized, and a more uniform pressure on the piston is attained for the same degree of expansion.

"With steam cut off at one-quarter stroke, the greatest force of the steam is exerted where it is least effective and produces more friction, while if we get the same expansion by cutting off at one-half and expanding into another cylinder, the action of the steam is obviously more effective.

"By the possibility of expanding two-fold, while giving full steam to one cylinder, and obtaining an eight-fold expansion by cutting off at one-fourth, greater and more profitable range is given to the engineman in graduating his cut-off.

"With all these theoretical advantages, a practical average saving of fuel of 17.1 per cent. over locomotives of similar construction with ordinary cylinders has been attained. This result is the average of the collective working of three compound engines—respectively, freight, passenger and omnibus engines—working against seven different ordinary engines of similar class and weight, for periods of from three to nine months each.

"The boiler pressure carried on the compounds was 180 lbs., while that of the other engines varied from 135 lbs. to 180 lbs.

"The valve gear of these compound engines is just as simple as that of ordinary engines, the links for both cylinders being set by the same movement of the lever and not capable of separate adjustment.

"It is to be noted that in this system both slides receive together the pressure usually thrown upon one for a given quantity of steam used, causing less wear on the parts.

"Since the pressure on the pistons is more uniform throughout the stroke, and since the work is more equally divided between the pistons, these engines run very steadily; and this, with the smaller quantity of fuel burned, makes the repairs for machinery and boiler less than usual, in spite of the high boiler-pressure carried.

"The great expansion of the steam diminishes the intensity of the blast so much as to cause little or no spark throwing from the stack.

"To ascertain the necessary diameter d, of the large cylinder, Mr. Von Borries uses the following formula:

$$d^2 = \frac{2\,Z\,D}{p\,h}$$

"Where Z = tractive force required = 0.14 to 0.16 of the adhesion weight—when allowance is made in Z for the external engine friction, taken as equal to that of the cars.

"D = driving-wheel diameter, inches.

"h = stroke, inches.

"p = mean effective steam pressure—after deducting internal machine friction—per square inch.

"This latter depends upon the comparative cross sections of the two cylinders, and from experience and indicator experiments may be taken as follows:

	Relative section of cylinders.	p in per cent. of boiler pressure.	p for 180 lbs. in boilers.
Large engines, with tenders..	1:2	0.45	81.0 lbs.
Tank engines,.....	1:2.25 / 1:2.3	0.42	75.6 "

"Engines for long, heavy grades should be proportioned for Z = 0.16 adhesion weight, that they may have large enough cylinders; but 0.14 is usually enough.

"For passenger and express engines the size of the small cylinder may be made on the usual basis, and the large cylinder of double the section, and the boiler pressure increased 15 lbs. to 30 lbs.

"It is desirable in general to proportion these engines so that they may ordinarily work at one-fourth to one-third cut-off.

"A compound engine of this kind will pull, according to Mr. Von Borries, 10 to 15 per cent. more than an ordinary locomotive with the same heating surface and grate area.

"The receiver between the cylinders is best constituted by a pipe passing, if possible, through the smoke-box, and if not, over the boiler, lying close to it and well protected from cooling off. The cubic contents of this connection pipe should not be less than that of the small cylinder, and it is better larger, in order to avoid too unequal back pressure on the small piston.

"In order to give as much power as possible for starting, it is necessary to bring pressure at once on both pistons. For this purpose an ingenious stop-valve has been contrived by Mr. Von Borries. This valve is placed in the connection-pipe between the cylinders, and when the throttle is first opened a small port gives entrance to steam behind the valve and holds it to a seat over the exhaust from the small cylinder, and allows the pressure from the boiler, reduced, however, by the small area of the port, to take effect on the large piston. As soon as the exhaust port of the small cylinder opens, the steam from this overpowers the pressure behind the stop-valve and forces it back to a seat, closing the small extra port above referred to. This port is then kept closed by the boiler pressure itself acting on a balancing device until opened by the driver by means of a special lever.

"Before opening the throttle, therefore, the engineer throws this lever over, and the opening of the throttle lets boiler steam

into both cylinders, which access is suspended automatically as soon as the exhaust of the small cylinder opens.

"The steam from the stacks of these engines is somewhat damp. This is not a sign of foaming, but an indication of the more perfect extraction of the heat and power from the steam.

"These engines make plenty of steam, particularly in fast running. The exhaust nozzles can be made 3/8 inch to 5/16 inch wider than usual, owing to the more uniform quality of the blast, with its low pressure and two gentle impulses instead of four violent ones in every revolution.

"Mr. Von Borries sums up the chief advantages of the compound engine very sensibly as follows: Better production of steam through more uniform blast, and better application of it through higher expansion and the possibility of getting a good expansion with very high-pressure steam, without unduly increasing the friction.

"From the uniformly good results attained by the three different methods of Mallet in France, Webb in England and Von Borries in Germany, and similarly good results by Worsdell in England, with an arrangement similar to Von Borries, it would seem as if the failure of the system to work on the Boston & Albany must have been due to an unsatisfactory application.

"The adverse experience with compound locomotives on the Kaiser Ferdinand Northern Railroad, of Austria, which by its own account lay entirely in the heavy repairs, seems to have been due to their injudicious use of the Mallet system. In this there are two sets of valve gear, to permit working either simple or compound; and the road in question found that in working high pressure on both cylinders the unequal pressure racked the engine-frame and working parts out of order.

"This high-pressure working, according to Mr. Von Borries' experience, is only necessary on the starting stroke, and he gets over the unequal pressure by contracting the throttles to the low-pressure cylinder."

An American Yacht for England.

THE Boston *Transcript* says: "The designs for a schooner yacht for Mr. Potter, a wealthy resident of London, England, in the hands of Mr. D. J. Lawlor, of East Boston, are nearly completed. Mr. Lawlor's success in designing fast vessels, notably the famous pilot boat *Hesper*, now in Boston waters, led to his receiving the English commission named above, visitors from the mother country having spread his fame among their fellows nautically inclined. The new yacht is to be 120 feet over all, 100 feet from stem to stern post, 24 feet beam and 12 feet draught. Her lines are finer than those of the *Hesper*, and her bow is longer. The area of her midship frame is 124 feet; area of load line, 1,551 feet; coefficient of midship frame, .54. Like the *Hesper*, she will be a thorough sea-going craft, roomy and comfortable, and calculated for great speed. The area of canvas she is to carry has not yet been determined; neither has the yard where she is to be built, whether British or American, been selected."

New Hudson River Steamboat.—A new iron steamboat for the Albany Day Line, on the Hudson River, was recently launched from the yard of the Harlan & Hollingsworth Company, at Wilmington, Del. The new boat is 300 feet long between perpendiculars, and 40 feet beam; her deck dimensions are 315 feet long and 75 feet beam. She will draw 6 feet of water, loaded. The paddle wheels will be 30 feet diameter, with feathering floats 12 feet 6 inches long by 44 inches wide. The engine will be of the ordinary walking-beam pattern, the cylinder 75 inches diameter and 12 feet stroke. There are three steel boilers of the cylindrical return-flue pattern, and the usual boiler pressure will be 60 lbs. The boat is to be ready for the summer travel.

Manufactures.

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THE ROGERS LOCOMOTIVE AND MACHINE WORKS.

(Continued from page 88.)

CHAPTER V.

GRATES.

With very few exceptions, the fuel used in the early locomotives in this country was wood. This could be burned successfully with an ordinary "plain" grate, as it was called, consisting of narrow bars with spaces about ½ inch wide between them. Figs. 64 and 65 show a grate of this kind, which was

Fig. 64.

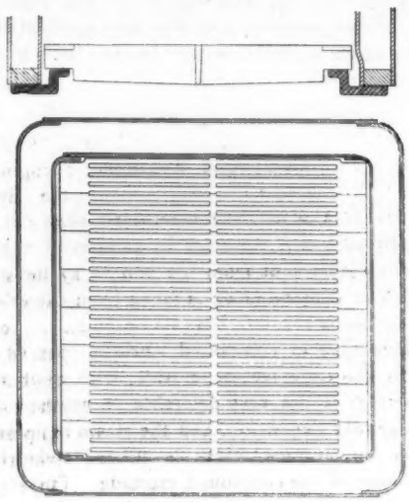


Fig. 65.

Fig. 66.

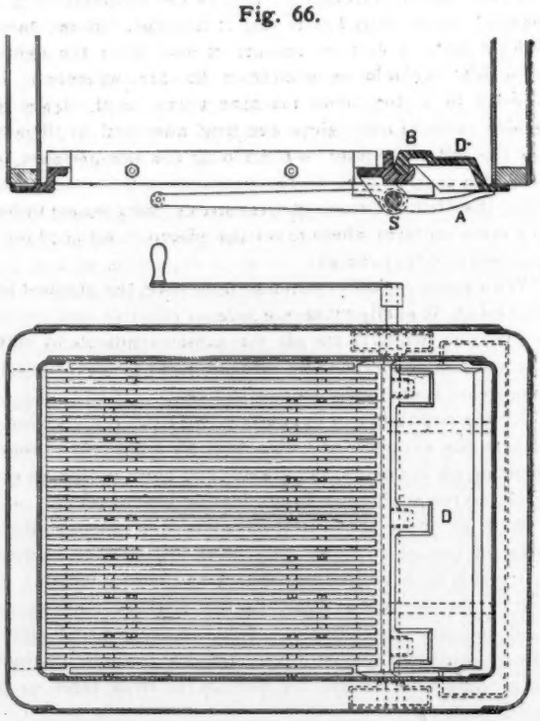


Fig. 67.

used in 1840. The bars were made of cast-iron, the material of which locomotive grates are almost universally made in this country. Figs. 66 and 67, however, represent a grate

made of wrought-iron bars, bolted together in groups of four bars each. The use of wrought-iron bars is, however, an exception to the general practice in this country. The grate shown in the figures last referred to has a drop-door D at the front end. This is hinged at B, and is held up by the arms A A, on the shaft S. To drop the door, the shaft is turned by the lever on the end of the shaft, which lowers the arms A A and allows the door to fall.

As much of the bituminous coal in this country contains a great deal of material which causes it to clinker, or otherwise interferes with its free combustion, it has been found essential to provide locomotives with what are called shaking grates for "clearing the fire." A number of different grates of this kind, which have been applied to locomotives at the Rogers Works, are shown by the following engravings:

Figs. 68 to 71 represent the Allen & Hudson grate, which was patented by Albert J. Allen and William S. Hudson in 1858. The grate is composed of a series of cast-iron bars with lugs on their sides, as shown in the plan. Underneath the bars are two cast-iron rocking-shafts, S S', which have arms *a a'* and *b b'* on their opposite sides. Each grate-bar has two projections *c c'* and *d d'* on its under side. To make it

Fig. 68.

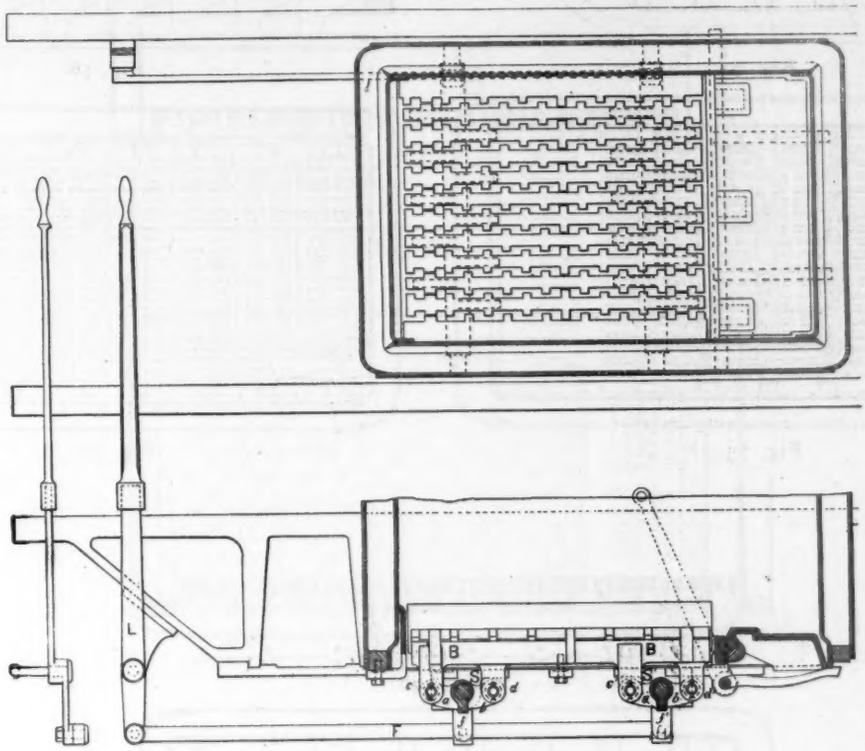


Fig. 69.

Fig. 72.

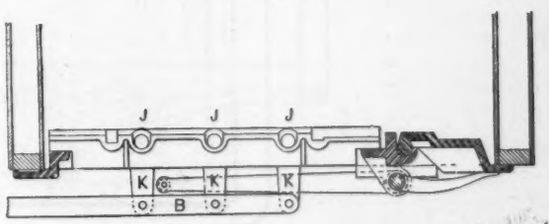
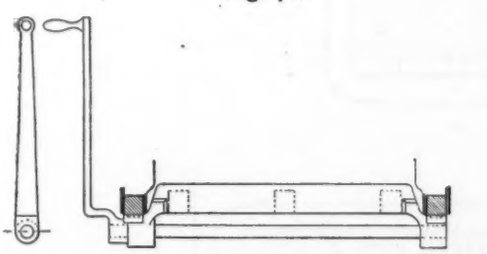


Fig. 70.



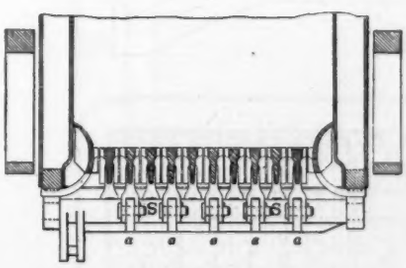


Fig. 71.

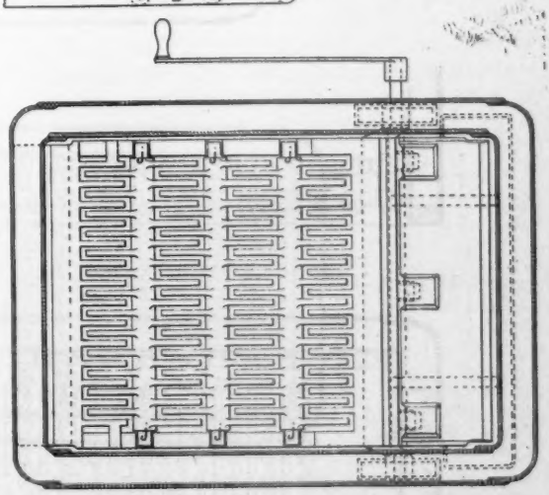


Fig. 73.

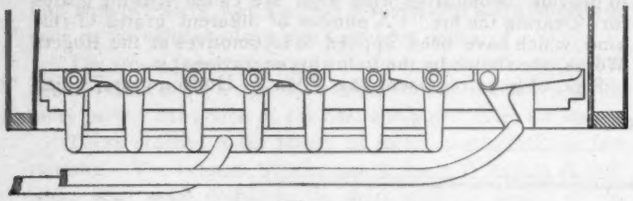


Fig. 74.

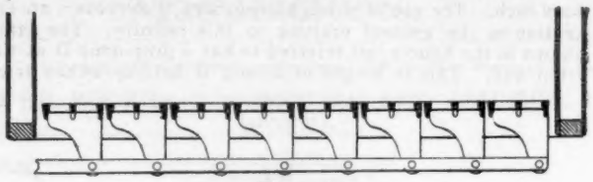


Fig. 76.

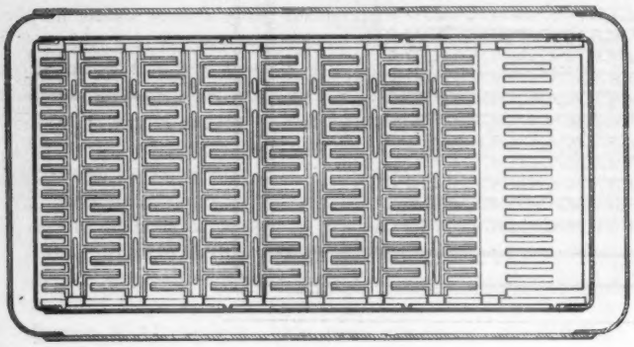


Fig. 75.

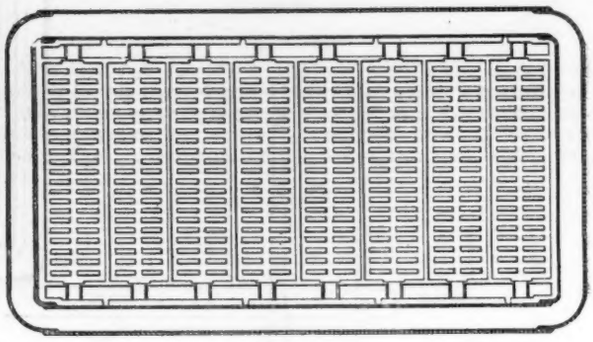


Fig. 77.

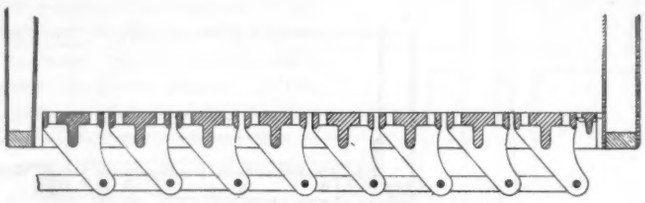


Fig. 78.

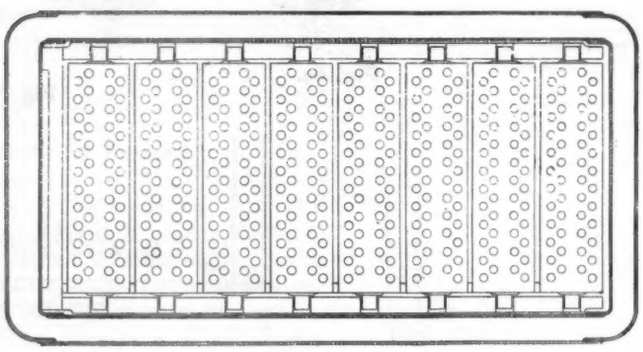


Fig. 79.

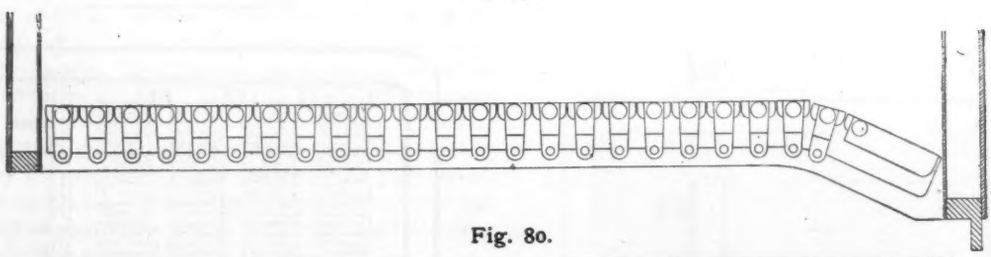


Fig. 80.

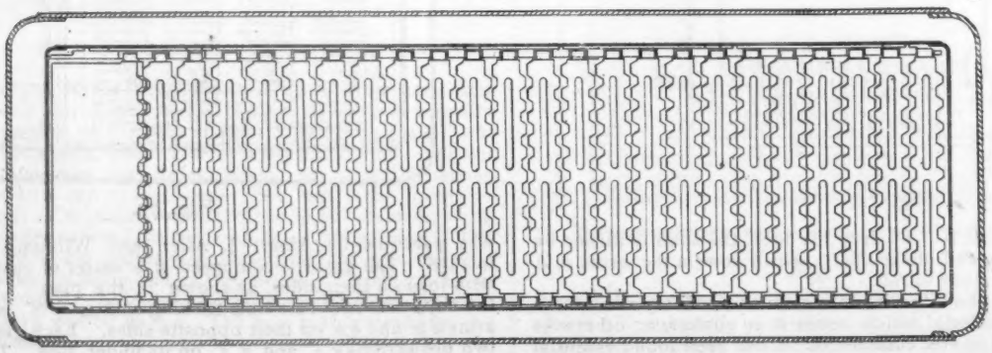


Fig. 81.

clear how the grate operates, it may be explained that the bar B B, shown in Fig. 69, has the two projections *c c'* attached to it, and that the projections *d d''* are attached to the bar next to B B. The projections *c c'* are connected by pins to the arms *a a'*, and *d d''* are attached to the arms *b b'*. It is obvious

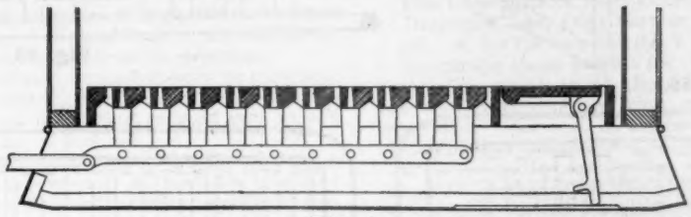


Fig. 82.

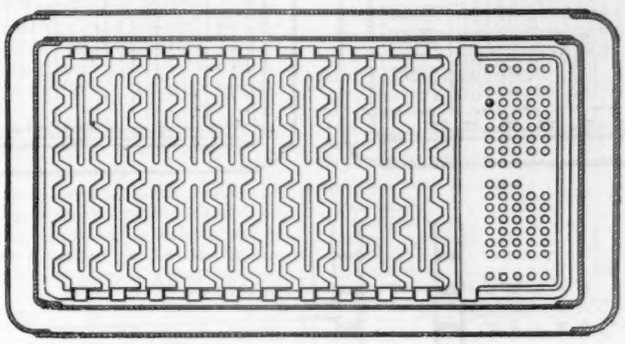


Fig. 83.

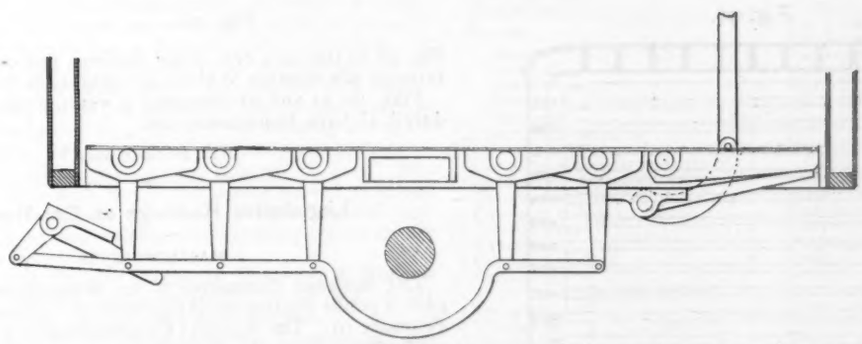


Fig. 84.

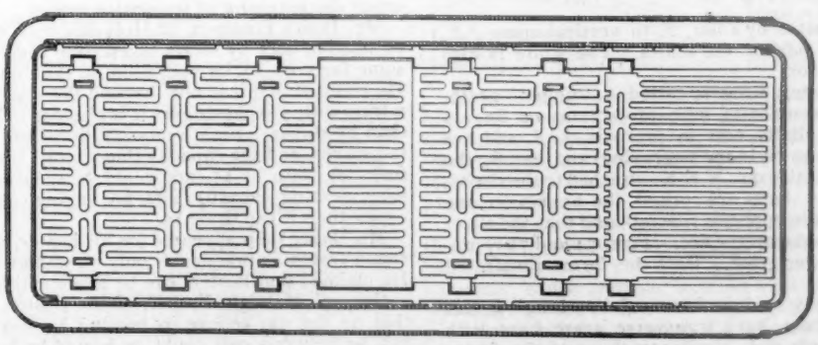


Fig. 85.

then, that when the shafts S S' are rocked, that the arms *a a'* will rise, and *b b'* will fall simultaneously, and *vice versa*, and that the grate bars connected to these arms will have a corresponding movement. As the alternate bars which compose the grate are connected to the arms on the right side of the shafts S S, and the bars between them are connected to the

arms on the left side of the shafts, it is plain that the working of these shafts has the effect of giving a limited upward and downward movement to the bars, in which each bar ascends as the next one on either side of it descends, and *vice versa*. This movement has the effect of breaking up the clinkers or other foreign or residuary matter that may collect upon the grate, and which tend to choke the draft between the bars, and to cause such matter to work down between the bars into the ash-pan, and also serves to evenly distribute the fuel over the grate.

The working of the shafts S S' is effected by means of the

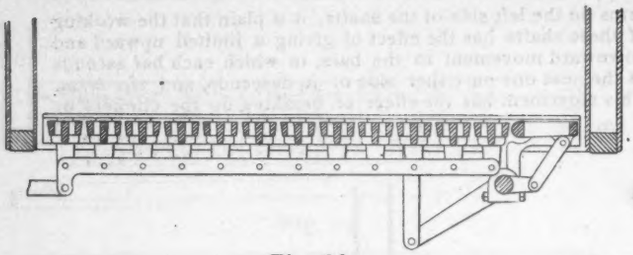


Fig. 86.

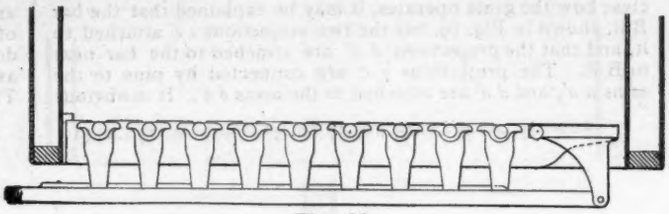


Fig. 88.

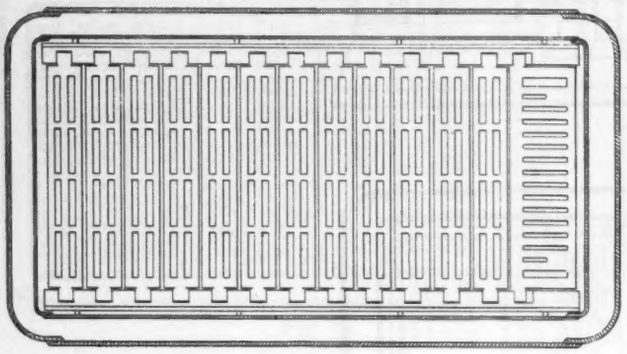


Fig. 87.

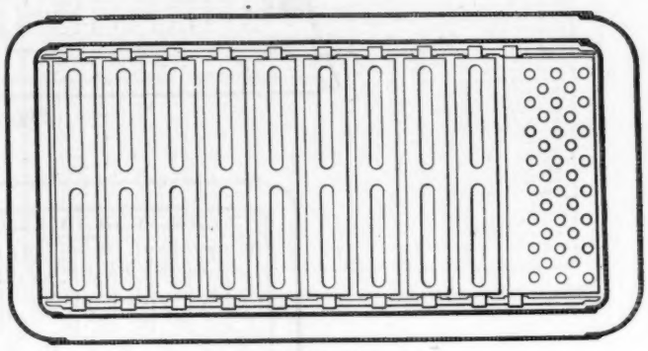


Fig. 89.

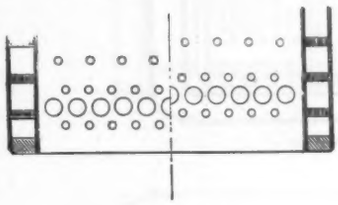


Fig. 90.

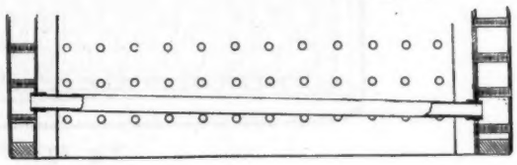


Fig. 91.

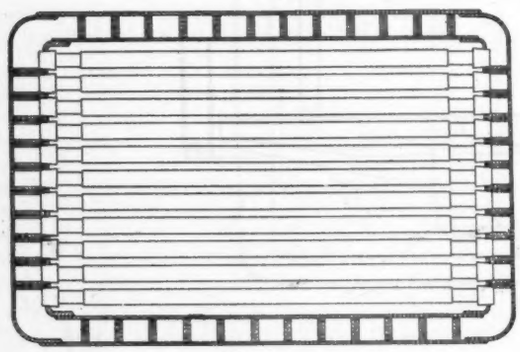


Fig. 92.

lever L, which is connected by a bar, F, to vertical arms, *f f*, attached to the under side of the shafts. The grate is also provided with a drop door.

Figs. 72 and 73 represent what is called a "finger" grate, which consists of cast-iron shafts, with projections or fingers on each side. These shafts rest in journals, *j j j*, and are rocked by a lever (not shown in the engraving) and bar B, the latter connected to vertical arms, K K K, attached to the shafts. It is obvious that, as the shafts are rocked, the fingers on one side rise, and those on the opposite side fall, and that the effect will be to thoroughly shake up the fire. Figs. 74 and 75 represent another form of finger grate. Both the forms illustrated were first used in 1860.

Figs. 76 to 89 represent various forms of "rocking" grates as they are called. These have transverse grate bars, with journal bearings at each end, similar to those of the finger grates. The bars are rocked on these journals, which has an effect similar to that of the finger grate in stirring up the fire. The construction and action of these grates will be obvious from the engravings.

For burning anthracite coal, the water-tube grate is almost universally used. The form used on the Philadelphia & Reading Railroad is shown in Figs. 30 and 31. The tubes are put in as shown in Fig. 31. Solid bars, B B, are substituted for every fourth tube. These bars pass through thimbles, T, Fig. 30, in the back end of the fire-box, and can be drawn out through this thimble to clean or remove the fire.

Figs. 90, 91 and 92 represent a water grate, recently introduced, to burn bituminous coal.

(*To be Continued.*)

Legislative Hearings on Car-Heating.

MASSACHUSETTS.

THE Railroad Committee of the Massachusetts Legislature gave a public hearing on the question of car-heating in Boston, February 10. The Railroad Commissioners, a number of railroad officers, patentees of heaters and others were present.

Col. Stott, of Lowell, appeared on behalf of persons who had petitioned for a law regulating methods of heating cars, and urged the necessity of legislative action.

Mr. James Emerson, of Holyoke, then described his method of heating cars by steam taken from the locomotive, and gave some facts as to its operation on the Connecticut River road. He claimed that it is now beyond the experimental stage. On a train with 300 passengers it is cheaper to heat from the engine than by stoves. Eight seats additional are gained by removing the stoves, and the capacity thus gained is worth more than the fuel. A train of 15 cars would be reduced to 13 and give the same seating capacity, and an engine can draw and heat 13 easier than it can draw 15.

Mr. Baker then appeared for his heater, and claimed that the steam system is practicable only on small trains and short runs. He claimed that heaters can be made entirely safe by casing.

General Manager Furber, of the Boston & Maine road, said that he did not believe in heating by steam from the engine; but he believed cars could be heated by hot water taken on at the stations.

The Gouge, Sewall, Thayer, Gold, Johnson, Chase, Burnhem and White systems of heating were explained to the Committee.

NEW YORK.

The New York Legislature on February 7 passed the following resolutions:

"*Resolved*, That the Board of Railroad Commissioners be and the same hereby are requested to report with all convenient

speed to this Legislature, whether there is any feasible method of heating and lighting the cars on passenger trains other than that now generally in vogue, whereby, in case of accident, the loss of life from fire, now oftentimes so severe, can be avoided; and if so, what legislation, if any, is needed to secure the adoption of such improved methods of heating and lighting by the various railroad companies subject to the laws of this State; and, also, that the said Board be requested at the same time to report any other and further measures or suggestions for practically increasing the security of life and limb in railroad travel, as may seem to it proper and desirable in the premises.

"*Resolved*, That the Railroad Commissioners be requested to report to the Assembly what legislation is necessary to compel the use of such methods of heating railroad cars as will ensure safety from fire in case of accident."

In pursuance of the above resolutions, the Board held a public hearing on Wednesday, February 16, upon the questions of improved methods of heating and lighting in railroad passenger cars. At this hearing there were present a number of representatives of various systems of heating cars.

Mr. Sewall explained his system of heating by steam taken from the locomotive, which is now in use on the Maine Central.

Mr. W. C. Baker described his heater, and claimed that the use of steam from the locomotive was not practicable.

Mr. J. B. Brady, of the Smith & Owen Heater Company, described that heater, and claimed that it could not be broken in any ordinary accident.

Mr. Medway (Master Mechanic of the Boston, Hoosac Tunnel & Western) said that they had tried a heater suspended under the car, and found it very unsatisfactory.

Mr. T. C. Shepard, of Albany, presented a plan by which he proposes to heat cars and light them with electricity. The idea is to have a dynamo in each car to be run from the axle of one of the wheels. By the current, water is heated so as to warm the car, and there is a storage battery in the plan to guard against long stops.

Mr. J. W. Cloud (Superintendent of Motive Power, New York, Lake Erie & Western) did not think any car could be properly heated and ventilated unless cold air is heated before it is brought in from the outside. The present system of heaters or stoves can be made comparatively safe. The trouble is that the heaters are built like egg shells and break too easily. Steam heating from the engine was also practicable, but it would take too much power to run a dynamo from a car-axle. It would be twenty times as great a demand on the engine as to take steam from it to heat the cars. The trouble with steam-heating was that hot water condenses in the rubber hose and spoils it. Any change in the system of car-heating would require additional plant and expense at terminal stations.

The discussion then turned on the lighting of cars. Mr. Rogers held that fires were just as frequently started by lamps and candles as by hot coals. Mr. Smith said a chemical electric battery was being successfully used for this purpose on the Boston & Albany road.

Mr. R. C. Blackall (Master Mechanic, Delaware & Hudson Canal Company,) offered the Commission the use of a car for experimental purposes, and the offer was accepted.

The investigation will be continued by the Commission, before a report is made to the Legislature.

The French Railroad Jubilee.—Active preparations continue to be made for the celebration of the 50th anniversary of the establishment of railroads in France.

The promoters of this jubilee have, however, recently received a check, which may prove a very serious one, to the projected celebration. Six of the great railroad companies of France have declined to take part in the proceedings at Vincennes in 1887. They are unanimous in regarding the proposed celebration as contrary not only to historic truth, but to the interests of the Exhibition in preparation for the 1889 centenary. They state that the first railroad in France was made previous to the year 1837, and to celebrate in 1887 the fiftieth year of their railroad system would be to give an impression contrary to truth; that other nations had been notably in advance of France. Further, to organize an especial exhibition in relation to railways and the divers industries connected with them, only two years previous to the great industrial manifestation of 1889, would be to rob the latter of a part of its attraction and *eclat*. The six great companies consider it their duty to reserve all their efforts for the national fêtes of the centenary. The Institution of Civil Engineers of France has declined to support this scheme, and it is reported that the Minister of Public Works has also refused it his support. It is also charged that the proposed celebration will really have no technical interest, and that the supporters of the scheme have not had engineering prominently in view.

New Inventions.

Patents.

February 19, 1887.

THE United States Patent Office passed to issue in the month of December, last, 1,637 patents, and in the month of January 1,448; or, for the two months in question, 3,085 patents.

Examining these patents for the purpose of making a comprehensive exhibit of all those covering devices intended for use on a railroad of any kind, we find that 221, or something more than 7 per cent. of the entire lot, are properly to be included in such exhibit.

With the understanding that, where there is no specific indication to another effect, the appliance designated is intended, primarily, for use on standard-gauge surface railroads operated by steam locomotives; the nomenclature used in the subjoined table sufficiently suggests the class of railroad service for which the invention named is intended.

Our inventors, then, in the brief period of eight weeks, have added to the stock of contrivances from which railway managers seeking improved appliances may select, the eleven score devices scheduled below:

Ash pan	1
Axle	1
Axle-box	3
Bogie—loose wheeled	1
BRAKES—TRAIN BRAKES—	
Pneumatic	1
Fluid pressure	2
Electro magnetic	1
Automatic	11
Locomotive	1=16
Brake attachment—hand	3
Brake-block-holder	1
Brake and wheel dresser	1
Brake-shoe	2
Cable railways	3
Cable railway-switch	1
Cable railway cable tunnel	1
Cable-grip	5
Car-couplings	41
Link-lifter	1
CARS—	
Box-car	1
Stock-car	5
Boudoir-car	1
Street-car	5
Hand-car	1=13
Contractors' dump car	1
Car lamp	2
Car-lighting apparatus, electrical	1
Car-heating apparatus	2
Car-door fastener, freight	1
Car-door, freight	3
Car-platform	1
Car-steps	2
Car-truck	2
Car-wheel	3
Wheel-measuring device	1
Car-seat	2
Car-spring	1
Car-mover	1
Car-starter	4
Car-pilot and guard	1
Car-replacing apparatus	1
Curve for street-road	1
Cattle guard	1
Exhaust mechanism	1
Foot-guard for frogs	1
Frog	1
Fire-door operating-mechanism, steam	1
Feed-water heater	1
Gate for car-platform	1
Gate for Crossings	3
Journal-brass	3
Journal oiler	1
Lathe for wheels and axles	2
Locomotive	1
Locomotive furnace	2
Locomotive boiler	1
Locomotive spring	1
Motor, for cars	1
Nut-lock	2
Pinch-bar	0
Railway, elevated	1
Switch casting for	2
Railway crossing	1
Railway operation at way stations	2
Railway, street, post for track support	3
Rail-joint	3
Rail-fastening	7
Rail-repairing mechanism	1
Rail chair	1
Seat for freight-cars	3
Snow-plow and scraper	1
Snow-plow	1
SIGNALS—	
Train	3
Road	8=11
Signal-lamp	2
Signal-fusee	1
Smoke-stack	1
Spark-arrester	1
Spike	1
Switch	4
Switch-plate	1
Switch stand	1
Tie, metallic	5
Tie, for cable road	1
Turn-table	1
Track-laying apparatus	1
Tamping-bar	1
Truck-assembling apparatus	1
Traction increaser	1
Ventilating apparatus for cars	2
Valve-gear	1
Wheel-truer	1

As promising to serve well in a direction in which improved practice is very desirable, we mention the steam-actuated furnace-door operating device, Patent No. 354,631. With this device in use the locomotive fireman, in order to open or close his fire-door, has only to press his foot upon a conveniently-placed pedal.

The fire-door shown in the drawings in this patent has two leaves, or valves, closing upon a medial vertical line. We suggest a division of the door upon a horizontal line across the doorway, which line may be somewhat above the middle of the fire-hole. With a door thus arranged, the edge of the lower leaf being suitably beveled, the fireman may, with his broom, send the sweepings of the foot-board directly into the fire-box; moreover, with this suggested arrangement the space necessarily left free for the lateral swinging of a door (or doors) hinged at the side, may be otherwise utilized. But, why not hinge the whole door at its upper edge; or, indeed, why not slide the whole door sidewise?

Another device deserving attention is the railroad crossing, patent No. 355,156.

The array of coupler men is fully up to the average—in number and in ingenuity. Very many of these patentees have, like

many of the army heretofore passed in review, gone to work in entire disregard (or ignorance) of the fact that a car-coupler, if it is to be of any *present* value, must be effective in coupling with the ordinary link-and-pin hand-smasher. J. M. G.

Proceedings of Societies.

Omaha Railway Club.

A NUMBER of the employés of the Union Pacific Railway have formed an organization known as the Omaha Railway Club, for the purpose of discussing matters connected with the railroad service. At the first meeting a committee was appointed to prepare a constitution and by-laws. The intention is to meet monthly in Omaha.

Cleveland Civil Engineers' Club.

A MEETING of this Club was held in Cleveland, O., February 8, at which nominations were made for officers to be voted for at the March meeting.

Mr. W. W. Christian, of Norwalk, O., then read a paper on Piping Natural Gas Long Distances, which was followed by a brief discussion.

Engineers' Club of Kansas City.

THIS Club was organized at a meeting held in Kansas City, Mo., February 6. It starts with thirty-three members, and its regular meetings will be held on the first Monday of each month.

The officers of the Club are: William B. Knight, President; J. A. L. Waddell, Vice-President; Octave Chanute, Clift Wise, Directors; Kenneth Allen, Secretary, Treasurer and Librarian.

Iowa Society of Civil Engineers.

THE annual meeting of this Association was held at Des Moines, Ia., February 3. The reports of the officers show that there are now 16 members.

The following officers were elected for the ensuing year: President, William Steyh, Burlington; Vice-President, M. Tschirgi, Jr., Dubuque; Secretary, F. A. Macdonald, Cedar Rapids; Treasurer, A. W. Swanitz, Cedar Rapids; Executive Committee, Conrad Eimbeck, W. W. Young.

Committees were appointed to arrange for the next meeting, and to take steps to extend the membership. It was decided to hold the next meeting at Des Moines on April 13 next.

Mr. Tschirgi read a long and interesting paper on City Engineering, describing the many important duties devolving upon the Engineer of a small city and the wide range of work expected from him. The Society then adjourned until April next.

Michigan Engineering Society.

THE eighth annual convention of the Michigan Engineering Society was held in Grand Rapids, Mich, January 25, with a large attendance.

The first papers read were a report on the Tamarack Mine by Charles D. Lawton, State Mining Commissioner, and a description by President Davis of the standard measure built in the hall of the main building of the State University at Ann Arbor. This rod is 103 feet long, is made of pine, and so arranged that it will remain in an equable temperature continuously. The measure was "standardized" by a 6-feet steel Coast Survey rod, and will be the future standard measure for engineers' tapes and chains in Michigan.

On the second day several papers were read and the following officers elected: President, George E. Steele, Traverse City; Vice-President, F. Guild, East Saginaw; Secretary, H. Hodgman, Climax.

Central Railway Club.

THIS Club, which was organized at a meeting held in Buffalo, N. Y., January 26, is the outgrowth of the meetings of master car-builders which have for several years been held in Buffalo, from time to time, to discuss the rules of interchange and settle disputed points. It has been agreed by those attending the meetings that a new Club was desirable, to be organized on much the same plan as the Master Car-Builders' Club in New York, the New England Railroad Club in Boston and the Western Railway Club in Chicago, and to fill up the wide gap now existing between the Eastern and Western organizations. The result is the Central Railway Club.

At the meeting of January 26, a constitution and by-laws were adopted, and all the necessary machinery put in motion. The officers chosen were: President, R. H. Soule, Buffalo, N. Y.; Vice-President, T. Sullivan, St. Thomas, Ont.; Secretary and Treasurer, E. Chamberlain, Buffalo, N. Y.; Executive and Financial Committee, R. H. Soule, E. E. Chamberlain, W. F. Turreff, F. B. Griffith, John Kirby and R. C. Blackall.

Meetings are to be held at Buffalo on the fourth Wednesday in March, May, July and October.

The establishment of a museum of railroad machinery and appliances is proposed, but no action has yet been taken on this point.

New England Water-Works Association.

A REGULAR meeting was held in Boston, February 9. Mr. Hiram F. Mills spoke of the newly organized State Board of Health (of which he is a member) and of what it proposed to do in matters which have especial interest for the Association. All inland waters in Massachusetts are now under the care of this Board, and no plan for water-supply or for sewage disposal can be carried out without first being submitted to the Board for approval. The Board has asked for an appropriation of $30,000, and proposes to expend one-third of this amount in having chemical and microscopical examinations of some 2,000 different samples of water, collected from all over the State. For one year samples are to be collected monthly, and after that time semi-annually. The first examination will have especial importance, as furnishing a standard for future comparisons.

Mr. Mills concluded by asking the members of the Association to co-operate with the State Board in protecting and improving the quality of the inland waters of the State.

Mr. Mills' remarks were followed by questions and discussion from Messrs. Tidd, Fitzgerald, Holden, Rotch, Darling and President Rogers.

Prof. George F. Swain, of the Massachusetts Institute of Technology, read a paper upon the Influence of Forests upon Rainfall, which will be published in the Journal of the Association.

The paper was briefly discussed by Desmond Fitzgerald, C. E., and Commissioner W. H. Hawes, of Fall River.

A paper by Albert F. Noyes, C. E., of Newton, upon Driven Wells, was postponed until the next meeting, on the second Wednesday in March.

Engineers' Club of Philadelphia.

A REGULAR meeting was held at the Club House in Philadelphia, January 22, President T. M. Cleeman in the chair; 25 members and 1 visitor present. The Secretary presented, for Mr. Conway B. Hunt, a paper on Hydraulic Dredging Machinery.

This paper mentions the early application of the principle of hydraulic dredging, that is, the mixing of dredged material with water, and then removing the mixture by suction or otherwise; and after referring briefly to the Roy, Stone and Bowers dredges as typical machines, describes in detail the Von Schmidt dredge. Two of these dredges are engaged on the improvement of the Potomac River at Washington, D. C., under the United States Government. In conclusion, it is noted that the devices and details of hydraulic dredging machines are the subjects of numerous patents, and their most efficient combination may be long deferred. The large number of machines that are still in the experimental stage of development would indicate that the best results attainable from this class of dredges have not yet been accomplished.

The Secretary presented, for Mr. W. E. Hall, a paper on Controlling Expansion in Locomotives.

Mr. E. S. Hutchinson described the Anderson Process of Water Purification on a Large Scale, as given by the inventor, and as in use in several European cities. The water, after settling, is forced through a revolving purifier, which consists, essentially, of a wrought-iron cylinder, mounted on hollow trunnions, serving for inlet and outlet pipes. The curved ledges, running lengthwise of the cylinder on the inner surface, scoop up and shower down through the current of water fine borings of cast iron. By the combined motions of the cylinder

and of the water current, every portion of the water is brought into contact with the iron, the particles of which are kept constantly bright by friction against the sides of the cylinder, against each other and the water.

Prof. L. M. Haupt then, by request, entered upon a discussion of the special questions involved in the improvement of New York harbor and of the proposed government work there.

Prof. Haupt submitted results of tests of the Tensile Strength of Canvas for the Club *Reference Book*. The club then adjoined.

A regular meeting was held at the Club House in Philadelphia, February 5th, President T. M. Cleemann in the chair; 26 members present.

The Secretary presented, for Mr. Morris P. Janney, a note upon the Differential Gauge as used at Blast Furnaces. The appliance was devised by Messrs. Taws & Hartman, engineers, Philadelphia, for the detection of irregularities in the working of blast furnaces in the neighborhood of the tuyeres. "The lower portion of a blast furnace, where the blast enters, is called the crucible. The blast passes through, generally from three to seven, and sometimes more, tuyeres, which are water-cooled castings placed in the wall of the furnace to prevent cutting. Although the blast is supplied to these tuyeres from one main, the air does not enter all of them at equal velocity at all times, and sometimes stops altogether at one or more of them without the furnace-keeper being able to tell by observation whether there is anything wrong or not. When the blast ceases to enter a tuyere through an obstruction coming in front of it, or the nozzle becoming clogged, it should be immediately opened by mechanical means until the blast enters again at the maximum velocity. Until the introduction of the little instrument I am about to describe, the trouble was to tell when the obstruction was removed or even existed; as a tuyere in this condition will frequently, for hours, appear about the same to the eye as a good, clear one. Also, if the blast be checked for any considerable time at one or more points, the rate of coal consumption diminishes as the volume of air lessens, causing slower descent of the charge at this point, and either forming a scaffold or giving a very good opportunity for one to form above the obstructed tuyeres, which, in the large majority of cases, will result in irregular and reduced yield of iron, and possibly, in the end, permanent obstruction of the whole furnace. The instrument consists simply of a small glass **U** tube, or its equivalent, filled to proper point with mercury. This gauge differs from the ordinary blast gauge in having both ends connected to the blast pipe at different points, instead of having one end only attached. Between the two points of connection there is a slight obstruction placed in the blast pipe leading to each tuyere, so as to make a difference in the pressure at the two points of connection. When the tuyere is clear, the difference of pressure is greatest and the mercury in gauge stands at different levels in the two legs. If a tuyere becomes obstructed in any way there is less and less difference in the mercury level, until, if the obstruction is considerable, it becomes level, thus indicating a very much reduced flow of air through the tuyere. Pipes are connected with each tuyere and all conveyed to same location where they are attached to separate gauges, and all the keeper has to do is to glance at the gauges, when they at once show the condition of the nozzles beyond question. This is one of the refinements of blast furnacing, and the development of the gauge reflects much credit on the makers. It has been introduced at a number of places, giving much satisfaction."

At the instance, also, of Mr. Janney, attention was called to the recent discussion of the Effect of Saccharine Matter on Mortars.

Prof. L. M. Haupt noted the Increased Weight of Locomotive Engines, as Affecting the Strains on Railway Bridges, instancing the dimensions of an engine recently constructed at the Baldwin Locomotive Works, which weighs 148,000 lbs., 134,000 lbs. being carried on the 10 driving-wheels. The greatest weight on one pair of drivers is 27,000 lbs. The tender weighs 82,000 lbs., and the live load of the engine and tender is 3,940 lbs. per foot.

Prof. Haupt also referred to two recent legislative matters of interest to engineers; the Wheeler bill for the examination of the earth's crust, and progress in the matter of rapid transit for Philadelphia.

American Society of Civil Engineers.

A REGULAR meeting was held at the Society's House in New York, on the evening of February 2, President Worthen in the chair.

Mr. Dorsey's paper on Irrigation was further discussed. Mr. George G. Anderson, Chief Engineer of the Northern Colorado Irrigation Company sent a written discussion, in which he dwelt on the necessity of storage reservoirs. The present duty in Colorado was 56 acres per cubic foot per second. The usual allowance of 50 per cent. for loss by evaporation and seepage was excessive with the best construction.

Mr. E. E. R. Tratman submitted some notes on Irrigation in Spain, and Mr. A. D. Foote noted a recent Arizona decision that owners of irrigation lands have inalienable rights to water supply, though they have no ownership in the ditch.

The Secretary read a paper by Prof. J. A. L. Waddell on Specifications for strength of Iron Bridges. The paper referred to the practice of working out strains to a fine point, the precise basis for which was little better than guess work. He thought a few empirical rules would be simpler and more practicable. He also referred to the question of uniform specifications and thought that, while a general specification might be made to cover ordinary work, special specifications should be drawn up for extraordinary work, such as cantilevers, long spans and braced piers.

This paper was discussed by Mr. Macdonald, who said that at a recent conference the manufacturers were able to agree on standard specifications, but the engineers would not give up their individual ideas. He did not think a uniform system of specifications possible or advisable.

Mr. Cooper thought that the manufacturers were not proper parties to prepare standard specifications.

President Worthen gave some reminiscences of the manner in which some of the old Howe-truss bridges on the Boston & Albany were widened for double track.

In response to a suggestion from the President, it was decided that all regular meetings should be called to order at 20.15 o'clock hereafter. The Society then adjourned.

The following have been elected members: David A. Maxwell, St. Stephen, N. B.; Silvanus Miller, Jr., Hatfield, Mass.; George S. Morrill, Boston; George F. Simpson, John Thompson, New York. Juniors: George H. Leland, Providence, R. I.; John M. Stewart, Dobbs Ferry, N. Y.; Arthur S. Tuttle, Brooklyn, N. Y.; Schuyler S. Wheeler, New York.

At the regular meeting on the evening of February 16, the death of Mr. W. W. Wilson, a member of the Society, was announced, and the usual committee to prepare a memorial was appointed.

Mr. Wm. H. Grant then read a paper on Calculation of the Mean Horse Power of a Variable Stream and the Cost of Replacing Power Lost by a Partial Diversion of the Flow. This paper was based on investigations made to determine damages due to a number of persons on account of the partial diversion of the flow of the Bronx River as a water supply for New York City; also to determine the cost of replacing the lost water-power by steam-power.

The paper was discussed by Messrs. Worthen, Emery, North and Davis. The discussion was, however, somewhat limited by the fact that some of the cases are still before the courts to determine the legal questions involved.

The Secretary exhibited some fine specimens of *teredo navalis* sent from Pensacola by Mr. Thorne.

Engineers' Club of St. Louis.

THE regular meeting of this Club was held at Washington University, St. Louis, on the evening of February 2, Vice-President Holman in the chair; 23 members and 7 visitors present.

A number of applications for membership were received and referred. Messrs. Arthur J. Firth, Charles H. Ledlie and Edward K. Woodward were elected members. Mr. R. S. Hays resigned on account of removal from the city.

Mr. J. A. Seddon then read a paper on Efficiency of Cable Roads; its Variation with Length of Cable and other Elements of the Construction. Mr. Seddon called attention to the lack of reliable data on the subject, and the difficulty of ascertaining results reached by roads now in operation The paper gave a thorough analytical and practical discussion of the subject and was of decided value. Mr. Seddon gave some results of recent tests on the St. Louis Cable road, but stated that the trials were not yet complete. The paper was discussed by Messrs. Johnson, Nipher, Adams, Bruner and Bryan.

It was voted that Dr. Adams' paper on Dynamo Electric Machinery be made the special order for the meeting of February 16.

Professor Nipher exhibited a piece of apparatus he had devised for determining losses in the magnetic fields of dynamos.

The Club then adjourned.

This Club met in St. Louis, February 16, President Potter in the chair; 18 members and 3 visitors present. Messrs. H. B. Gale, Otto Schmitz and Arthur Thacher were elected members. Several applications for membership were announced and referred.

The Secretary read a letter from Mary G. Smith acknowledging the receipt of the Club's testimonial to the late C. Shaler Smith.

The Secretary also read a communication from Jno. W. Weston, Commissioner-General for the United States for the Paris Railway Exposition and Jubilee, on the desirability of the Club being represented in some way. The matter was referred to the Executive Committee.

Dr. Wellington Adams then read a paper on Design and Construction of Dynamo Electric Machinery, which was illustrated by diagrams and electrical apparatus. The subject was handled in a thorough manner, and a number of formulæ were given showing how the efficiency of any dynamo could be calculated. It was shown that these formulæ held the same relation to the dynamo machine that the indicator card does to the steam engine. The paper was discussed by Messrs. Gale, Nipher and Seddon.

The President announced the subject for the paper for the next meeting to be Present Aspect of the Problem of the Inter-Oceanic Ship Transfer, by Robert Moore. The Club then adjourned.

Illinois Society of Engineers and Surveyors.

THE Illinois Society of Engineers and Surveyors held its second annual meeting at the State University at Urbana, Ill., beginning January 26th, with a large attendance.

Vice-President T. J. Burrill delivered the address of welcome in behalf of the University, and responded to by C. G. Elliott, Chairman of the Executive Board, on behalf of the Society. Next came the address of the President, Professor I. O. Baker, of the civil engineering department of the University. The address was confined to a short review of the advances made in the different departments of civil engineering throughout the civilized world, but more particularly in the United States, during the past year. It was highly interesting and closely listened to by his audience.

After the President's address reports of committees were heard and the following elected members: John R. Lewis, Piper City; Samuel S. Greely, Chicago; Daniel W. Mead, Rockford; Fletcher H. Chapman, Carlinville; Thomas S. McClahan, Monmouth; George V. Loring, City Engineer, Decatur; Jacob J. Foster, County Surveyor of Cook County, Chicago; Frank V. Alkire, Petersburg.

At the evening session the first report was that of the Committee on Sanitary Engineering and Water Supply, by Professor A. A. Talbot, Champaign. The different kinds of systems of water works was discussed at length, and the faulty construction of stand-pipes exposed.

S. A. Bullard, City Engineer of Springfield, read a paper on Combined *versus* Separate System of Sewerage for Small Cities. The combined system is that in which one system of pipes is used, while the separate system is that in which two systems of pipes are used—one to carry off storm; surface and cellar water, and another to carry off refuse from dwellings. The benefits and advantages of both systems were discussed at some length. In regard to sewer ventilation it was found that in some cities in the State, street openings were found the best, while in others manholes were the most satisfactory.

Samuel S. Greely, of Chicago, read an interesting paper on the License System for Surveyors. He contended that as the law is now the private surveyor had the advantage of the county surveyor, because he has the same advantages and not the drawbacks of the latter. He argued that the State should license engineers and surveyors, the same as physicians and lawyers. In the discussion that followed, it was agreed that surveyors and civil engineers should be entitled to the fees of experts when compelled to attend court.

On the second day a number of papers of much interest were read. Prof. D. O. Baker, of the University of Illinois, delivered an illustrated lecture on Bridges. Prof. Theo. B. Comstock, a paper on Natural Gas and Oil in Illinois, which elicited great interest, and much information on that subject was gathered from various members in the discussion which followed.

Other papers read were: Pavements for Small Cities, by George F. Wightman, City Engineer, Peoria; Water Supply for Small Cities, by K. R. Croswell, City Engineer, Kankakee; Railroad Trestles, by E. A. Hill, Chief Engineer, Indianapolis, Decatur & Springfield Railroad.

The following officers were chosen: President, I. O. Baker, Champaign; Vice-President, J. T. Foster, Chicago; Executive Secretary, A. N. Talbot, Champaign; Recording Secretary, S. A. Bullard, Springfield; Treasurer, G. P. Ela, Bloomington.

The Society adjourned in the evening, after a very successful meeting.

The Master Car-Builders' Club.

A MEETING of the Club was held in the rooms, 113 Liberty Street, New York, on February 17. Mr. C. E. Garey called the meeting to order. Action on the change of name and organization was postponed. The subject on discussion was the lighting and heating of cars. Mr. Baker was called on and said his heater had warmed a million of people. He claimed to have been the first one who suspended a stove below the car. His company was engaged in perfecting a heater which should be protected in case of collision. He said he had offered Mr. Depew to equip a train of cars with safety heaters and then have a collision. In case the heaters set fire to the car their company would pay the costs.

Mr. Creamer said that the newspapers insisted that cars should be heated from the engine. He thought that a stove or heater could be made safe. He inquired whether all the other elements of safety were attended to. Were the baggage-car stoves safe? He thought that the fires generally originated in the baggage, mail and express cars. If steam heat is used he would place a coil of pipe at the end of the car, and introduce a current of air over the pipes and warm the air.

Mr. Smith, of Dunkirk, N. Y., representing the Martin Heater, said all stoves in cars are dangerous. If the fire was inclosed in a Krupp gun the fire would be heard from in case of collision. He advocated the removal of the stoves from the cars. He represented a company which had trains on the Boston & Albany and a number of other roads, some of which had been in service for three years. The system takes steam from the locomotive, and the pressure is reduced.

Mr. Emerson spoke in favor of his system of heating.

Mr. Hopkins said that the use of steam prevented entirely the danger from fires and this part was very important.

Mr. Gold, of New York, said his system was in use in 900 cars on various roads. He described his system, which consists of a receptacle for water, which is heated by a steam-pipe which passes through the water. By this means the heat is stored in the water. Mr. Bernstein, who represented Mr. Cline, exhibited a heater in which he used a fuel that he said would not set fire to anything. A member put some of the burning fuel in a newspaper which was set on fire by a gentle breeze.

Mr. Owens exhibited one of his heaters, which is made of boiler-plate, with a coil of pipe inside. Several other methods of heating were described, but nothing new or important was exhibited.

New England Railroad Club.

THE regular monthly meeting of this Club was held at its rooms in the Boston & Albany passenger station in Boston on the evening of Wednesday, Feb. 9. President J. W. Marden occupied the chair, and there was a large attendance, about 160 persons being present, including many prominent railroad officers.

After the meeting had been called to order a committee was appointed to nominate officers to be voted for at the annual meeting in March.

The regular order—the Heating and Lighting of Cars in Passenger Service—was then taken up.

Mr. A. A. Folsom (Boston & Providence) asked for particulars in relation to a recent accident on the Fitchburg road.

President Marden (Fitchburg) gave an account of the accident referred to, in which two passenger cars and a sleeping car were overturned, but the heaters in the cars were not injured and the cars did not take fire.

Mr. J. N. Lauder (Old Colony) said that, in view of the recent terrible accident in Vermont, the railroad members of the Club, at least, ought to approach the subject of heating cars with the greatest care, and be prepared to throw over their preconceived notions if necessary. He was still of the opinion that cars have, for years to come, got to be heated individually, and the question is how to do it safely. He was free to admit that trains can be heated by a continuous system from the engine, but there are many difficulties in the way of its general adoption for all roads and all trains. He thought that the hot-water heating system is the only one yet proved to be a success, and one way of making it safe is to enclose the heater in a steel box, which will

not let the fire out into the car in case of derailment. The cost, he believed, would not stand in the way of its adoption by any railroad.

President Marden said that public opinion, as expressed in the newspapers and elsewhere, was evidently in favor of some system of heating by means of steam from the locomotive, and he would like to hear from gentlemen present some opinions on this question.

Mr. F. D. Adams (Boston & Albany) said that he was still a believer that steam heat is the coming heat. It is true there are some difficulties, but he thought they were not insurmountable. He believed the officers of his road were satisfied they have got to heat their cars with steam from the locomotive for both safety and economy. The success of the Martin heater has been such that they had no general fault to find, and he thought that before the winter had gone another train will be equipped. The train now equipped has not lost a trip, and that cannot be said of some other heaters, for they are frequently in the shop for repairs of the pipes. Steam heating is being put in almost all buildings, and the stations at all points can easily be equipped with steam-heating apparatus and a pipe be run from it to heat cars before being attached to the engine. Mr. Adams told about the success in warming the cars in the coldest weather of the past month He said Mr. Lauder's plan was feasible, but he did not approve it because he thought steam is the coming heat. He thought that five years hence a good many trains, in New England at least, will be heated with steam, and the time is coming when it will be as universal as the Westinghouse brake.

Mr. Robert Miller (Michigan Central) said he thought that steam-heat apparatus would have to be put in at terminal stations to heat the cars before they started out. In case the train was snow-bound and the engine fire gone out he thought a supplementary heater in the cars would have to be provided. He thought, perhaps, there is as much danger from lighting as from heating, and both should be guarded against.

Mr. J. T. Woodward (Portland, Me.) was invited to explain the Sewell heater, a system of steam heating from the locomotive now on trial on the Maine Central road. He said that a car of the present style is really as perfect a man-trap, in case of collision, as could well be devised. The passengers sit with their feet under the seats, which slide together in case of collision, pinning them down; and, the heaters breaking, let their fire out among the upholstery, which is thoroughly dried and prepared for rapid combustion. He then described the Sewell system in general terms.

Mr. Sewell, the inventor of the heater, followed by describing its mechanical construction. Steam is taken from the engine, both exhaust and direct, through a peculiar patent coupling in the center of the car. The piping is along the side of the car instead of having convolutions of pipes under the seats. In the aisle of the car is a simple valve for turning on the heat. Steam is taken at a very low pressure, and the cars are kept at a temperature of 70° or more. A hot-water well under the car is provided for superfluous water, and a provision is made for heating it by a grate beneath. [Mr. Sewell here exhibited his patent coupling, used to connect the pipes in different cars.] Cars equipped with the Sewell heater would not couple with the Martin system, but if the same coupling was used, which could readily be done, the two systems could be run together. Mr. Sewell stated that the heater had been in operation since 1880, though he had been at work perfecting it from that time to the present. The pipes used are 1¼ or 1½ inch, three of them on each side of the car.

Mr. R. H. Blackall (Delaware & Hudson Canal Company) said that he could not say what difficulties would stand in the way of taking steam from the locomotive on his road.

Mr. G. H. Griggs (Providence & Worcester) said that he could see no objections to heating his cars with steam from the engine, though if his road connected with other roads he should want to know if the other road was to put it on before he did.

Mr. Robert Johnson (inventor of the Johnson heater) read recommendations showing that his heater furnishes abundant heat in the coldest weather. He said that, as regards safety, his heaters have been in several accidents and the fire has been immediately extinguished.

Mr. R. B. Owen (Detroit, Mich.) explained the manner in which the Smith & Owen Heater Company guards its heaters from all danger of setting the cars on fire. The heater consists of a steel boiler made of plates ¼ inch thick, and surrounded by a water-space 1¼ inch wide; the boiler is bolted firmly to the floor; the doors to the fire-box and the ash-box are protected by a sliding steel sheet, securely fastened. The steel boiler is as strong as any locomotive boiler, and would not be broken by collision.

Mr. Adams said it was evident from what had been presented that steam heating is practicable, and he was more firmly convinced than he ever was before that steam is the coming heat.

Mr. Edward E. Gold (New York) described his system of steam heating, which is in use on the elevated railroads in New York. He said his system is substantially the same as those described by others, except in the method of storing the heat. He uses two pipes, one within the other; the outer one is 4 inches in diameter and the inner 3½ inches. The inner pipe is filled with hot water, which is heated by the steam at the same time the car is heated. The car can be kept heated from five to seven hours after being detached.

Mr. J. N. Lauder said that any system of steam heating, to be adapted to the use of the railroads running into Boston, must be capable of warming at least 12 cars.

Mr. Waterman Stone (Providence, Warren & Bristol) said that they had just equipped a train with the Gold system, having decided on that system because of its capacity for storing heat. He promised to tell the Club at its next meeting how that system had worked.

Mr. Peck explained a casing of boiler iron which had been invented to put over any heater in a car, and which works automatically. He also exhibited a model of the invention.

Mr. Baker (inventor of the well-known Baker heater) described his heater and claimed that the system of heating with steam from the engine is only suitable for short roads or runs.

On account of the length of the discussion on the heating question, the second branch of the subject—Lighting—was postponed until the March meeting, and the Club adjourned.

The next regular meeting, which will be held at the usual place on Wednesday, March 9, will be the annual meeting, at which the reports of officers will be presented, and officers will be elected for the ensuing year. After this routine business has been transacted, the subject of Lighting Passenger Cars will be discussed.

The Master Car-Builders' Brake Committee.

A MEETING of the M. C. B. Committee on Freight Train Brakes was held at the Hotel Anderson in Pittsburgh, February 9. The meeting, as previously announced, was held to determine the rules and conditions governing the brake tests to be held at Burlington, Ia., prior to the Master Car-Builders' convention in June next.

The Committee first held a private meeting, after which a joint meeting was held of the members of the Committee and the representives of the brake companies. At the joint meeting the rules prepared by the Committee were submitted, fully discussed and finally agreed upon.

There were present at the meeting Messrs. G. W. Rhodes, Chairman, J. S. Lentz and D. H. Neale, of the Committee, and the following representives of the different brake companies that propose taking part in the tests: American Brake, Geo. H. Poor; Carpenter Air Brake and Carpenter Electric Brake, Thomas Prosser, Jr.; Eames Vacuum Brake, Jas. H. Slade and N. W. Howson; Hanscom Automatic Air Brake, W. W. Hanscom; Park Electric Brake, H. S. Park and W. Sherman; Rote Brake, C. F. Harding; Waldumer Electric Brake, L. W. Goss; Westinghouse Brake, T. W. Welsh, S. H. Sprague, Levi W. Close and F. Moore; Widdifield & Button Brake, W. D. Widdifield; Ward Brake, W. H. Ward. Mr. F. S. Wood acted as Secretary.

It was decided that the tests at Burlington should begin on May 9, instead of in April. The tests to be made are as follows:

TESTS.

1. Fifty empty-car trains making 4 emergency stops; first, 20 miles per hour on a level; second, 40 miles per hour on a level; third, 20 miles per hour on 53-foot grade; fourth, 40 miles per hour on same grade.

2. Fifty mixed-car trains, two-thirds of the cars loaded, one-third empty, 75 per cent. of the latter being in front half train; first, second and third stops as above, fourth stop on grade at 30 miles per hour.

3. Fifty mixed-car trains with hand brakes and engine and tender automatic brakes; four emergency stops; first, on a level at 20 miles per hour; second, at 30 miles per hour on a level; third, at 20 miles per hour on 53-foot grade; and fourth, at 30 miles per hour on same grade.

4. Train of 50 mixed cars to be let down a 53-foot grade 3 miles long; speed 20 miles per hour at top of grade to be reduced to 15 miles per hour as soon as practicable and maintained without material variation to the foot of the grade.

5. One or more runs over the course to be made with trains having brake shoes ½ to ¾ in. off the wheels before the brakes are applied.

6. Fifty mixed-car trains; tests on the level; trains to be broken into two or more unequal parts, speed 30 and 20 miles per hour; after the train is broken any assistance will be ren-

dered only by a brakeman, who shall be riding at the rear of the train or on the engine when the breakaway occurs.

7. Train resistance test; fifty-car mixed trains, first to pass No. 1 stop post at 20 miles per hour, letting the train drift to a stop, no brakes being applied; second, to pass No. 3 post at 5 miles per hour, letting train drift until No. 4 post is passed, at which point the accelerated speed shall be recorded and the train stopped.

THE RULES.

The rules as adopted are given below:

1. Each brake company will provide its own engine; such as do not wish to furnish a special crew will be furnished from working crews of Chicago, Burlington & Quincy Railroad. Ordinary eight-wheel, four wheels coupled engines must be employed; each engine must have 17 × 24 inch cylinders and not less than 51,000 lbs. on the drivers; both tender trucks must be provided with brakes and cast-iron shoes; plain wrought-iron shoes to be used on the drivers. Each brake company to have the option of using its own or such other engine brake as it can procure.

2. Each brake company will furnish, fitted with its brake, 50 box cars of 40,000 lbs. capacity or over, and 34 feet long being preferred. Each car to be equipped with brakes on both trucks and plain cast-iron shoes. The cars to be delivered to the Committee, free of charge, at some point on the Chicago, Burlington & Quincy Railroad on or before May 2. After the trial the cars will be returned to the owners at the points of delivery.

3. The Chicago, Burlington & Quincy Railroad will not be held responsible for mileage of cars while on its lines or for any damage to the cars that may occur through the inefficiency of the brakes.

4. Close couplings are recommended, and companies using link and pin couplers must be provided with wedges to take up slack. Half the stops will be made with close couplings and half with slack, should any of the brake companies so elect.

5. In operating brakes they must be applied and released by the engineman only, except as specially provided for in test No. 6, special tests.

6. Three runs over the course will be made with tests one, two and four. Two runs will be made with test number six, and one run with tests numbers three, five and seven.

7. Sand must not be used on any of the stops except with the special permission of the Committee.

8. The leverage of the brakes will be recorded by the Committee, and none of the apparatus must be changed at any time during the trials, except as previously provided.

9. With continuous brakes the pressures carried on the engine prior to the application of the brakes will be recorded for each test.

10. All tests to be made under like conditions of rail, grade, etc., as near as possible.

11. A dynamometer car will be placed in the front end of each train with complete recording mechanism. In the middle box-car of each train a portable apparatus will be placed for recording diagrams, showing, first, a strain line in pounds exerted on the brake lever during the stops; and, second, a speed line in miles per hour during each stop. An electrical signal will be arranged for communication between the front and rear ends of the train.

12. Competitors will be subjected to all the general tests; special tests will be optional.

13. The rapidity with which the train gets away after a stop will be noted, the time being taken from stop to start. In case breakages or causes foreign to the brake interfere with getting away, the record will be thrown out.

14. The parts pertaining to each brake, other than the foundation brake, hose and diaphragms, will be painted a red-lead color.

15. Each brake company will use its appliances in the manner it shall consider best, provided that in the opinion of the Committee such methods are safe and practicable in ordinary working.

16. The Committee reserves the privilege of adding such tests as in its judgment may be deemed desirable.

17. Three or more competitors will be required before the tests will be entered into. Any competitor desiring to enter the tests should communicate with the Chairman on or before April 1.

18. The Committee are not in a position to furnish equipment for these tests, but regards the subject of great interest to railroads and trust they will contribute to its success by furnishing engines and cars to the competing brake companies and affording them any other reasonable facilities.

The shocks during the stops will be measured by the movement of the "slidometer," a 16 lbs. turned iron weight free to slide in a planed pine trough placed horizontally in the way car at the rear of the train. A movement of more than 12 inches will be considered objectionable, as indicating a shock violent enough to injure stock.

Tests 6 and 7, which relate to trains breaking away and the frictional resistance of the cars, are special tests, and are therefore optional.

National Electric Light Association.

THE annual meeting of this Association began in Philadelphia, February 15, with about 100 members present.

The meeting was called to order by President J. Frank Morrison, who made an address reviewing the work done in electric lighting during the past year. Brief addresses were made by Mr. Thomas Dolan and Col. A. Loudon Snowden.

After routine business had been disposed of, the Committee on Standard Gauge reported, through A. V. Garratt, of Boston, in favor of rejecting the British standard and establishing a new gauge to be called the National Electric Gauge. Mr. C. C. Haskins, of Chicago, then read a paper on High Insulation. At the evening session Prof. E. R. Weeks, of Kansas City, read a paper on Popular Prejudice Against Electric Light Wires, and a commission of five, consisting of Prof. Houston, M. M. Garver, Prof. Marx, Reuben T. Robinson and C. Herring, was appointed to investigate the best system of insulation for electric-light wires.

On the second day, Mr. Stuart, of the Legal Committee, presented a paper on Irregularities in Decisions of the Patent Office, accompanying it with a bill which he urged should be presented to the next session of Congress. It was called for by the want of uniformity in the decisions which emanate from time to time from the respective Commissioners of Patents, and which ought to be corrected. The bill provides for a Commission of three, to be appointed by the President of the United States, which Commission shall examine the present patent, trademark and copyright laws of the United States and those of other countries, and shall formulate a report to be presented to Congress setting forth the results of the investigation and the conclusions of the Commission, together with an act providing for such changes as may be found necessary.

Later on in the session a resolution was adopted referring the matter to a committee of five to present the bill to Congress.

J. H. Shay, of Chicago, presented a paper on Transmission of Power by Belting, in which he stated that for electric-light machinery it was desirable to use evenly-matched belting of uniform thickness.

The subject of Electric Motors was discussed in a paper read by W. H. Baxter, Jr., of Baltimore. This paper was discussed at length by F. J. Sprague, of New York, and Prof. Houston, of Philadelphia.

A communication from the Electric Club of New York was read, urging the appointment of a committee by the National Association to coöperate with a similar committee from the Club in considering the question of uniform rules and regulations for governing the installation of electric-light plants. The latter was referred to the Committee on Insulation.

A. F. Upton, of Boston, presented a paper on Plans for Electric Light and Power Stations, in which he gave practical hints on equipment and the furnishing of plants, dwelling particularly upon the necessity of considering the possibilities of growth.

A. J. De Camp, of Philadelphia, Chairman of the Executive Committee, offered a resolution providing for the appointment of a committee of five to tabulate rates for motor service, based upon rates for arc and incandescent-light service, from stations developing over 300 horse-power.

In the evening the Association visited, on invitation, the Franklin Institute, where a number of subjects were discussed of general scientific interest. The visitors were welcomed in a speech by Mr. Joseph M. Wilson, President of the Institute, to which a response was made by President Morrison.

At the close of the session a number of the visitors accepted the invitation of the Keystone Light & Power Company to visit its station on Sansom Street.

On the third day, Mr. F. H. Ball, of Erie, Pa., read a paper on the Direct Transformation of the Heat Energy of Coal into Electrical Energy.

This was followed by a paper on the Electrical Motor, as applied to the Propulsion of Street Cars, by Mr. Charles J. Van Depoele, of Chicago. In this paper reference was made to the advance made in this direction, and an account was given of the work done by the electric motor in Minneapolis.

Mr. Joseph Wetzler, of the *Electric World*, spoke of Incandescent Lighting from High Potential Circuits. He referred to

the demand for incandescent service to be supplied from stations, and the obstacles which had been met in introducing such service. The object aimed at was to reduce the quantity of copper required for the distribution of the current to incandescent lamps. This could be accomplished by increasing the electro-motive force employed on the circuit and reducing correspondingly the total current required. To accomplish this he suggested the use of storage batteries.

Dr. Otto A. Moses, of New York, treated the subject of the Distribution of Electrical Energy by Means of Secondary Generators. He argued that, by the use of secondary generators, currents of 20,000 or 30,000 volts could be as readily and safely generated and distributed as those of the present limit of 500 or 700 volts. He predicted that by this means the vast power of Niagara Falls could be utilized and even transmitted to New York in the near future. He spoke at length of the secondary generators now in use in the incandescent system in Pittsburgh.

Mr. I. Fugioka, a Japanese engineer, then made an address, in which he described the electric-lighting system of Tokio, Japan. The Tokio Electric Light Company, organized a year ago, supplies 2,000 incandescent lamps and about 100 arc lights from its plant, located in the suburbs of Tokio. The system embraces the residences of the upper classes, and also furnishes light to the new palace. Mr. Fugioka gave some interesting information concerning the rapid progress of electrical science in Japan and the extensive use of the telegraph and telephone.

Mr. S. Yoshima, President of the Tokio Electric Light Company, was also present, and both gentlemen were elected honorary members of the association.

The election of officers resulted as follows:

President, J. F. Morrison, Baltimore. First Vice-President, E. R. Weeks, Kansas City. Second Vice-President, A. J. De Camp, Philadelphia. Treasurer, Charles Cooper, Brooklyn. Secretary, Thomas McCoubray, Baltimore. Executive Committee, F. A. Gilbert, Boston, Chairman; George S. Bowen, Elgin, Ill.; Frank Ridlon, Boston; Stephen Holbrook, Philadelphia; Dr. Otto Moses, New York; Eugene T. Lynch, New York; J. F. Noonan, Paterson, N. J.

The Association adjourned to meet in Boston in August. Most of the members left for New York during the afternoon to attend a dinner of the Electric Club and listen to a paper by Mr. Stephen D. Field on Electric Motors.

American Institute of Mining Engineers.

THE forty-seventh meeting of the Institute began at Scranton, Pa., on the evening of Tuesday, February 15. Vice-President James D. Weeks called the meeting to order.

The Secretary, Dr. R. W. Raymond, then read a letter of regret from President Richards, who is now in Bermuda on account of his health. This was followed by Dr. Raymond reading a biographical sketch of the late Mr. Martin Coryell, who recently died at Lambertville, Pa., and who was one of the founders and the first Secretary of the Institute. Dr. Persifor Frazer then made some remarks on the progress which had been made in the work of the International Geological Congress at the last session in Berlin, and made an earnest appeal to the members of the Institute to look more thoroughly into the matter, and see that at the next session of the Congress, to be held in London in 1888, America be well represented. Dr. T. Sterry Hunt then spoke a few words indorsing the remarks of Dr. Frazer.

The meeting was then adjourned so that the members could attend the handsome reception prepared for them by the citizens of Scranton. The members were all taken in charge by the local committee, and introduced to the ladies and gentlemen of Scranton. The evening was passed in pleasant social intercourse, and was closed by a handsome collation.

Wednesday was devoted to a visit to the extensive works of the Lackawanna Coal & Iron Company and a drive through the City of Scranton. In the evening a business session was held.

On Thursday morning the members visited the Pine Brook coal-breaker, and also the large shops of the Dickson Manufacturing Company. Business sessions were held in the afternoon and evening.

On Friday there was an excursion over the Delaware, Lackawanna & Western road and a visit to several coal mines. A business session at 4 P. M. and the annual dinner in the evening closed a very successful meeting.

The following papers were presented at this meeting, several of them being discussed at much length:

The Animikie Rocks and their Vein Phenomena, as shown at the Duncan Mine, Lake Superior; by W. M. Courtis, Detroit, Mich.

Concentration and Smelting at Tombstone, Arizona; by John A. Church, Tarrytown, N. Y.

Experiments in Matting Sulphides; by E. Gybbon Spilsbury, New York City.

Magnesium Carbonate as a Non-Conductor of heat; by E. Luttgen, Ambler, Pa.

Notes on the Saving of Sulphur and Ammonia from Gas; by W. H. Adams, New York City.

Rail-Sections; by W. F. Mattes, Scranton, Pa.

The Bessemer Department of Jones & Laughlins, Limited; by P. Barnes, Pittsburgh, Pa.

General Account of the Iron Ores used in the Chattanooga District; by H. S. Fleming, Dayton, Tenn.

Comparison of some Southern Cokes and Iron Ores, by A. S. McGreath, Harrisburg, Pa., and E. V. D'Invilliers, Philadelphia.

Apparatus for Volumetric Determinations with Potassic Permanganate; by Clemens Jones, Hokendauqua, Pa.

The Microscopic Structure of Steel Rails; by F. Lynwood Garrison, Philadelphia.

Distribution and Proportions of American Blast-Furnaces; by John Birkinbine, Philadelphia (carried over from the St. Louis Meeting).

Geology and Mining of the Northern Anthracite Coal Field of Pennsylvania; by Frank A. Hill, Philadelphia.

A Water-cooled Producer; by W. J. Taylor, Chester, N. Y.

Western Railway Club.

THE regular meeting was held in Chicago, February 16, President Scott in the chair. There was a large attendance.

Mr. G. W. Rhodes made an announcement of the brake tests at Burlington, giving the rules for the trials, which will be found elsewhere.

The subject of Car Heating was then introduced by Mr. Allen Cooke, who referred to the public demand for some substitute for stoves. Letters from several parties were read.

Mr. Barr (Chicago, Milwaukee & St. Paul) said that they were trying the Martin and the Westinghouse systems of steam heating, but were not yet prepared to report results.

Mr. Martin (Martin Anti-fire Car Heating Company), by request, described his system at considerable length, answering many questions from members.

Mr. Rhodes said that when electric lighting was introduced the impression was that gas would be dispensed with. In practice both are used, one to help the other. Something similar will probably happen with car heating. Fire in the locomotive rarely causes fire in wrecks, because it is properly protected. Stoves could be made equally safe.

The discussion was further continued by Messrs. Mead, Townsend, Barr, Martin, Schlacks, Quayle, Forsyth, Kirby and Pullman.

Mr. Sinclair said that there was no danger from the explosion of steam pipes in the cars, the steam having too low a pressure.

Mr. Kirby said that the Lake Shore road would apply the Martin system to a suburban train for trial. It was also stated that the Rock Island road would try the Westinghouse heater.

The Interchange Rules were then taken up. Rules 17, 18 and 19 were approved. Rule 15, it was voted, should be amended by substituting the words "kind and quality of material" for "kind of material." Amendments to Rules 16 and 20 were also suggested.

It was decided to continue the subject of Car Heating at the March meeting; to be opened by Mr. William Forsyth. The balance of the Interchange Rules will also be discussed, the subject to be opened by Mr. Mead.

Steel Rail Prices in Europe.—A contract for 13,000 tons of steel rails for a new line in Portugal was recently let to the Bochum Steel Works in Germany at 112 francs ($21.75) per ton. Bids were received from Krupp at 113 francs and the Cockerill Company at Seraing, Belgium, at 116 francs.

An order for 21,000 tons of steel rails for Italy has been divided, the Ebbw Vale Company (England) taking part at 112 francs, Bolckow, Vaughan & Co., England, part at 120, and the Cockerill Company, Belgium, the rest at 120 francs.

The Council of Public Works of Italy has recommended that the bid of the Terni Steel Works be accepted for the supply of 150,000 tons of steel rails for new branch lines. Delivery is to extend over four years, the price to be 169 lire ($32.75) per ton loaded on cars at the works.

PERSONALS.

Mr. D.W. C. Perry is Chief Engineer of the Parsons & Pacific, a new Kansas road.

Mr. T. Marino is now Assistant Engineer of the new Augusta & Chattanooga road in Georgia.

Mr. A. J. Vosburgh is Chief Engineer of the Ripley & Mill Creek Valley, a new West Virginia railroad.

Captain Henry M. Adams has been promoted to be Major, Corps of Engineers, in place of Suter, promoted.

Mr. William Cappeller has been appointed Railroad Commissioner of Ohio, to succeed Mr. H. C. Apthorp.

Mr. Thomas Downing has resigned his position as Master Mechanic of the St. Paul, Minneapolis & Manitoba road.

Passed Assistant Engineer Frank H. Bailey, U. S. N., has been assigned to duty at Cornell University, Ithaca, N. Y.

Mr. R. H. Temple has been appointed Chief Engineer of the new Tennessee Midland Railroad, with office in Memphis, Tenn.

First Lieutenant William M. Black has been promoted to be Captain, Corps of Engineers, in place of Adams, promoted.

Mr. H. W. Hamilton has been appointed Superintendent of Construction of the Minneapolis, Sault Ste. Marie & Atlantic road.

Mr. E. P. Moulton has resigned his position as Master Mechanic of the Vermont Division of the Boston & Lowell Railroad.

Mr. J. R. Hoffman, Engineer of the Carthage & Adirondack Railroad, has resigned his position and has gone to Colorado.

Second Lieutenant Hiram M. Chittenden has been promoted to be First Lieutenant, Corps of Engineers, in place of Black, promoted.

Naval Constructor Fernald has been ordered to San Francisco, where he will supervise the construction of the new cruiser *Charleston*.

Mr. William J. Cochran, Sr., has been appointed Master Moulder of Ordnance, and has been assigned to duty at the Washington Navy Yard.

Mr. T. H. Perry, Chief Engineer and Purchasing Agent of the Lake Erie & Western road, is continued in that position on the reorganization of the company.

Mr. George A. Ferguson, Master Mechanic of the White Mountains Division of the Boston & Lowell road, has been given charge of the Vermont Division also.

Mr. O. D. Richard has been appointed Engineer of the Lake Shore Division of the Lake Shore & Michigan Southern Railway, in place of L. C. Brewer, resigned.

Mr. William Rogers, for some years past General Superintendent of the Central Railroad of Georgia, has been appointed Assistant to the President of that company.

Mr. D. H. Blackham has resigned his position as Superintendent of the Susquehanna Division of the New York, Lake Erie & Western road, on account of continued ill health.

Mr. Ross Kells has been appointed Superintendent of Motive Power of the New York, Pennsylvania & Ohio divisions of the New York, Lake Erie & Western road, with office at Cleveland, O.

Mr. Nathan P. Hobart, of New York, has been appointed Chief Engineer of the Vincennes & New Albany, a new railroad in Indiana. His headquarters will be in New Albany, Ind., for the present.

Mr. W. H. Starr, late Roadmaster of the Eastern Division of the New York, Lake Erie & Western road, has been promoted to be Superintendent of the Rochester Division in place of G. W. Bartlett, transferred.

Mr. R. E. Hardaway, who has been Chief Engineer of the Americus, Preston & Lumpkin Railroad during its construction, has resigned that position. His address will be at Tuscaloosa, Ala., for the present.

Mr. William E. Good has resigned his position as Master Mechanic in charge of the Philadelphia & Reading shops at Reading, Pa. He will connect himself with a large manufacturing enterprise in Philadelphia.

Mr. W. T. Reed has been appointed Master Mechanic of the St. Paul, Minneapolis & Manitoba Railroad, with office in St. Paul, Minn., in place of Thomas Downing, resigned. Mr. Reed was recently on the Canadian Pacific.

Mr. George G. Crocker, of Boston, has been appointed a member of the Massachusetts Railroad Commission in place of Thomas H. Russell, deceased. He is a lawyer, and, like Judge Russell, will be the legal member of the Board.

Mr. F. W. Sargent has been appointed Engineer of Tests of the Chicago, Burlington & Quincy Railroad in place of E. M. Herr, transferred to other duties. Mr. Sargent has been for some time employed in arranging the rail record of the road.

Mr. A. M. Tucker, for some time past Superintendent of the Western Division, New York, Pennsylvania & Ohio, has been transferred to the main line of the New York, Lake Erie & Western road, as Superintendent of the Susquehanna Division.

Mr. H. W. Reed, Roadmaster of the Savannah, Florida & Western, has been appointed Secretary of the Roadmasters' Association of America in place of Mr. D. H. Lovell, resigned on account of ill health. Mr. Reed's address is Waycross, Georgia.

Mr. George W. Bartlett, late Superintendent of the Rochester Division of the New York, Lake Erie & Western road, has been transferred to the company's leased New York, Pennsylvania & Ohio line as Superintendent of the Western Division.

Mr. Morris S. Belknap, formerly on the Louisville & Nashville, and more recently Superintendent of the Vicksburg & Meridian and the Vicksburg, Shreveport & Pacific roads, has been appointed General Superintendent of the Central Railroad of Georgia.

Mr. Herbert Hackney has been appointed Assistant Superintendent of Machinery of the Atchison, Topeka & Santa Fé Railroad. He is a son of Mr. George Hackney, the Superintendent of Machinery, and has had charge of some important work, on the road and elsewhere.

Mr. William H. Stevenson has resigned his position as Superintendent of the New York Division of the New York, New Haven & Hartford road. He has been connected with that road for fifteen years. It is said that he will accept an important position on the New York & New England road.

Mr. George Hackney, Superintendent of Machinery and Car Department of the Atchison, Topeka & Santa Fé Railroad, has had his authority extended over the Atlantic & Pacific and the California Southern roads, which are controlled by the Atchison Company. Mr. Hackney's office will remain at Topeka, Kan.

Mr. George L. Fowler, Editor of the American Railway Publishing Company's paper (the *American Journal of Railway Appliances*, the *Street Railway Journal* and *Power*), has been appointed First Assistant Commissioner to the International Railway Exposition to be held in Paris during the coming summer. His address is No. 113 Liberty Street, New York.

Mr. E. M. Herr, for some time past Engineer of Tests of the Chicago, Burlington & Quincy Railroad, has been appointed Acting Superintendent of Telegraph, with office at Aurora, Ill. Mr. Herr has recently been giving much attention to telegraphic work, especially in connection with the application of the quadruplex system to the company's lines.

Mr. Henry Cope Whitehouse has succeeded in calling the attention of the Egyptian Ministry of Public Works to his project for restoring the ancient Lake Mœris as a storage reservoir in which a portion of the overflow of the Nile can be retained and used for irrigation in the dry season. Engineers are to make a careful examination and report on Mr. Whitehouse's plans.

Mr. R. R. Bridgers, Jr., has been appointed Engineer of Maintenance of Way of the Western North Carolina Division of the Richmond & Danville Railroad. Mr. Bridgers has been for some time on the Pennsylvania Railroad in the maintenance of way department; he is a son of Hon. R. R. Bridgers, for many years President of the Wilmington & Weldon Railroad Company.

Mr. C. C. Wrenshall, Engineer of Maintenance of Way of the Northern Pacific, has resigned to accept the position of Superintendent of the Woodstock Iron & Steel Company, at Anniston, Ala. He will have charge of the building of that company's furnaces and steel works, and also of the location and construction of a railroad from Anniston to Gadsden, which the company intends to build. Mr. Wrenshall has been with the Northern Pacific since that line was completed.

Captain A. W. Greely, Fourth Cavalry, has been appointed Chief Signal Officer of the Army, with the rank of Brigadier-General, to succeed Gen. W. B. Hazen, deceased. Capt. Greely served through the war, having enlisted as a private in the 19th Massachusetts Regiment in 1861. After the war he received a commission in the Regular Army, and for 18 years

past he has been in the Signal Service, for several years being second in command. He is well known to the public from his service in the Signal Corps and from his connection with Arctic explorations.

Mr. John W. Cloud will succeed Mr. R. H. Soule as Superintendent of Motive Power of the New York, Lake Erie & Western road. Mr. Cloud has served in the motive power department of the Pennsylvania Railroad for a number of years; for six years past he has been Engineer of Tests, and on the death of Mr. J. B. Collin last year, he was appointed Mechanical Engineer also. Mr. Cloud joined the Master Car-Builders' Association in 1883, as representative member for the Pennsylvania Railroad, and has since taken a prominent part in its proceedings.

Mr. R. H. Soule has been appointed General Manager of the New York, Lake Erie & Western Railroad. The office is a new one on that road, and Mr. Soule will take part of the work heretofore performed by Vice-President Felton. Mr. Soule is still a young man, having been born in 1849. He graduated from Harvard College and entered the service of the Pennsylvania Railroad as a draftsman in the Altoona shops in 1875, receiving a position as assistant in the test department two years later. After two years of test and inspection work he was made Superintendent of Motive Power of the Northern Central road in 1879, and in 1881 was transferred to the Philadelphia & Erie. A year later, he was again transferred to the Pittsburgh, Cincinnati & St. Louis road, and in 1883 he resigned his position there to become Superintendent of Motive Power of the New York, West Shore & Buffalo road, where he remained until December, 1885, when he was made Superintendent of Motive Power of the New York, Lake Erie & Western, succeeding Mr. F. M. Wilder. On the Erie, Mr. Soule has been occupied in reorganizing the motive power department thoroughly, and it has doubtless been his efficient work there which has led to his promotion. Mr. Soule joined the Master Car-Builders' Association as a representative member, and has been prominent both in the conventions and in committee work.

Notes and News.

Cable Railroad in California.—The San Jose & Santa Clara Railroad Company has been organized to build a cable railroad 10 miles long from San Jose, Cal., to Santa Clara and Alum Rock.

New Steamer for the Allan Line.—Bids have been asked for in Glasgow for a new steel steamer of 5,000 tons for the Allan transatlantic line. The new steamer is to have triple-expansion engines.

American Machine Tools for France.—The Bridgeport (Conn.) Machine Tool Works recently shipped to France some machinery, which is said to be the first part of a very large order for tools for making fire-arms for the French Government.

Elevated Railroads in Cincinnati.—A bill has been presented to the Ohio Legislature providing for the organization of companies to build elevated railroads in Cincinnati. The routes proposed must be inspected and approved by the Railroad Commissioner.

The Hancock Inspirator.—The Hancock Inspirator Company celebrated the manufacture of the 100,000th inspirator by a dinner at the Quincy House, Boston, on the evening of February 21. A number of guests were present, and appropriate speeches were made.

Heavy Rails.—The Société Cockerill, at Seraing, Belgium, is rolling some rails of the Sandberg pattern, weighing 101 lbs. per yard. These will be the heaviest rails ever made, and are to be used at certain points on a line where trains are run at very high speed.

Shreveport Sewerage System.—A system of sewerage has been finally arranged for the City of Shreveport, La., and a contract for the work has been let to Samuel R. Bullock & Co., of New York. The pipes will be supplied by Blackmer & Post, of St. Louis.

Elevated Railroads in Chicago.—The Chicago Rapid Transit Company has taken steps to secure right of way for an elevated railroad through State and other streets. The project meets with much opposition, but the company promises to begin work early in the spring.

Hawkesbury River Bridge.—Work was actually begun on the foundations of this Australian bridge in October, and early in January one pier was down 15 feet in the solid, with 25 feet of concrete in it and 50 feet of the iron shell in place, and another caisson nearly ready for launching.

Railroads in the Italian Army.—The Engineer Corps of the Italian Army, under a new reorganization, is to include four companies of railroad men, experienced in the construction and operation of railroads, and one company of men competent to build and operate telegraph lines.

Improving the New York Canals.—Bills are before the New York Legislature providing for the improvement of the Erie and the Champlain canals. One bill provides for the expenditure of $500,000 for the purpose of lengthening locks near Syracuse, while another provides for more extensive works.

Price of Locomotives in England.—It is reported that the Lancashire & Yorkshire Railway has recently placed an order for thirty locomotives at £37 10s. a ton (equal to $180), which is said to be the lowest figure ever touched for that class of work. The Vulcan Foundry Company, Newton-le-Willows, is the contractor.

Cannon Making in Japan.—The German correspondent of *The Engineer* says: "According to news from Berlin, Krupp has lately made an arrangement with the Japanese Government to establish a branch of his cannon-making business in Japan, and is to manufacture all the heavy artillery the Government may require."

American Brake Company.—This company has been making additions to its works in St. Louis, including a new machine shop with a full equipment of tools. This has given the Superintendent, Mr. G. H. Poor, an opportunity to rearrange the works with a view to promoting economy and convenience in working.

Grade Crossings in Connecticut.—The Connecticut Railroad Commissioners, like their Massachusetts brethren, recognize the fact that highway grade crossings over railroads are a nuisance not to be tolerated in a thickly inhabited country, and in their report they strongly urge the passage of a law providing for their complete abolition.

Prince Edward Island Tunnel.—A company has been organized with $5,000,000 capital stock to build the proposed tunnel under Northumberland Straits, to connect Prince Edward Island with the mainland of New Brunswick. The company asks the Canadian Government to guarantee 4 per cent. interest on the cost of the work.

American Institute of Mining Engineers.—The officers chosen at the Scranton meeting to serve for the ensuing year are: President, Prof. Thomas Egleston, New York. Vice-Presidents, John Birkinbine, Philadelphia; J. F. Holloway, Cleveland, O.; E. S. Moffat, Scranton, Pa. Member of the Board of Managers for two years, C. Kirchhoff, Jr., New York.

Heavy Guns.—Commander G. W. Sumner, U. S. N., contributes a paper to the *Army and Navy Journal*, in which he argues very strongly against the efforts recently made to secure further experiments with cast-iron guns. He claims that such experiments would be merely a waste of time and money, in view of the experience already had with such guns in this and other countries.

Southern Coast Defenses.—A convention was held at De Funiak Springs, Fla., February 8, at which memorials were prepared for presentation to Congress, asking that steps may be taken to provide proper defenses for the Southern Atlantic and Gulf ports; also asking for the establishment of a manufacturing arsenal in the mineral region of Georgia, Alabama or Tennessee.

Steel Ties in England.—The Northeastern Railway Company (England) has recently placed with Bolckow, Vaughan & Co. an order for 2,000 tons (about 20,000 ties) of steel ties of the pattern adopted on the road. This, it is understood, is the first instalment of a very heavy contract. Bolckow, Vaughan & Co. have now at their works, at Eston, a special plate for making these ties.

Electricity, Effects of in Iron When Cooling.—Lieut. Zalinsky, the inventor of the dynamite gun and submarine torpedo boat, it is reported, on the authority of the *New York Herald*, has been making some preliminary tests which have shown that iron cooled while a strong current of electricity was passing through it was increased fully one-half in tensile strength and ductility.

Underground Telegraph Lines.—A London correspondent of *Science* says that during the controversy on overhead *versus* underground lines in England, the following statements have been put forward on authority: The English Post-office has 20,000 miles of underground lines, as against 22,000 in Germany. The cost of an underground wire is £350 per mile, and

of every additional wire, £15, as against £35 and £10 respectively for overhead wires. Underground wires diminish the speed of signaling from 25 to 75 per cent. over long distances. The cost of renewal and maintenance is about the same in both cases.

Close of an Old Mill.—The Fall River Iron Works, at Fall River, Mass., which were started in 1842, have been closed permanently. The mill made nails, hoop, band and bar iron, and its capacity was about 11,000 tons of finished iron yearly. The reason for closing is that the owners have found it impossible to compete with mills in Pennsylvania and other States close to the supplies of fuel and raw material.

Hardness of Metals.—In describing his instrument for determining the relative hardness of metals, by scratching with a weighted diamond—the harder the metal the heavier being the weight—Mr. T. Turner has remarked that the true hardness did not vary, as was commonly supposed, according to the tenacity, and that accounted for the difference which was often seen in the wear of railway rails. He also pointed out that in cast-iron the softest metal was really the strongest.

The Industrial Problem.—The *American Machinist* says that, "the great industrial problem is the discovery and adoption of some plan to afford work for the unemployed," and thus concludes its article on the subject by saying, "we believe that no other remedy exists for getting rid of the growing army of enforced idlers, than cutting down the hours of daily labor." This is a very simple remedy for this wide-spread evil, and, like homœpathic medicine, will be pleasant for the laborer to take.

Russian Ship Canal.—Some attention has been directed in Russia to a project for a second connection between the Sea of Azof and the Black Sea by a canal through the Isthmus of Perekop, which connects the Crimea with the main land. As now outlined it is proposed to build a canal 12 feet deep and 65 feet wide through the Isthmus, with ports at each end. The object of the canal is to avoid the dangerous navigation of the Straits of Kertch.

Safety Heating and Lighting.—An Omaha letter says that a new plan for securing safety is to be tried on the Union Pacific road. It is proposed to have an iron car attached to the train, in which will be a boiler to supply steam for heating the cars and the reservoir containing gas for lighting them. No fire will be allowed in any other car, and, as the gas lights in the passenger cars will be at once extinguished in case of accident, it is believed that danger of fire will be almost entirely removed.

Profits for Employes.—H. K. Porter & Co., in Pittsburgh, builders of light locomotives, recently issued a circular to their employés, saying that during the year just closed the work in the shops had been exceedingly well done. To show their appreciation of honest endeavor and fair dealing they therefore make cash presents to all the men in the shops, on the following scale: Foremen, $50 each; gang-bosses, $25 each; mechanics, $15 each; laborers, $10 and apprentices $5 each.

Electric Locomotives in London.—Trials have been made in London of the Elieson electric locomotive. This is a motor driven by a storage battery, the motor being placed below the vehicle and communicating its power to the wheels by bevel gearing. The locomotive weighs 6½ tons and the car attached to it 2½ tons, empty; the car will carry 46 passengers. Locomotives of this pattern are to be used on a suburban section of the North Metropolitan Tramway Company's line. The run is 5 miles each way.

New Ships for the Navy.—The House Committee on Naval Affairs recommends the passage of a bill providing for the construction of two steel cruisers of 4,000 tons burden, to be of the same type as the *Newark*, now building; four steel gunboats of 1,700 tons displacement, and one steel torpedo boat for cruising, to be about 150 feet long and capable of making 20 knots an hour. The cost of the cruisers is not to exceed $1,300,000 each, without armament; of the gunboats, $525,000 each; and of the torpedo boat, $100,000.

Natural Gas in Ohio.—A syndicate has been formed to pipe natural gas from the wells at Findlay, O., to Columbus and Cincinnati. A 4-inch main will be laid. The sydicate controls light wells with an average product of 30,000,000 cubic feet.

In Wood County there are now 18 wells, producing an average of 44,000,000 cubic feet of gas daily.

Arrangements are in progress to put down pipes from the gas wells in Mercer County to Dayton, Springfield and other manufacturing towns.

Wind Derailments on Narrow-Gauge Roads.—A severe wind-storm on February 18 proved too much for the narrow-gauge roads in Colorado, no less than four trains having been blown from the track. On the Denver & Rio Grande a passenger train of 5 cars was blown from the track, and a freight train of 20 cars was also derailed, both near Colorado Springs. On the Denver & South Park a passenger train of 3 cars was blown down a bank near Morrison and another passenger train was blown from a bridge near Como; in the last accident several passengers were hurt.

Large Stationary Engine.—Douglas & Grant, of Kirkcaldy, Scotland, have nearly completed a compound Corliss Engine of unusual size for a cotton mill in Bombay. The engine has a high-pressure cylinder 40 inches, and low-pressure, 70 inches diameter, the stroke being 6 feet. The fly-wheel is 30 feet diameter by 8 feet 6 inches face, and is grooved for 38 wire ropes, by which the power is to be transmitted to the different sections of the mill. The steam pressure is to be 100 lbs. and the engine is to run at 60 revolutions, it is expected to work up to 2,500 H. P. without difficulty.

New Bridge Contracts.—Contracts for two important bridges have recently been let. The first is for a steel bridge over the Ohio River, between Cincinnati and Covington, for the Chesapeake & Ohio or Huntington system of railroads. This bridge will be built by the Phœnix Bridge Company at Phœnixville, Pa.; the cost will be about $1,000,000.

The second contract is for a bridge over the Mississippi at Fort Madison, Ia., for the Chicago, Santa Fe & California, which is the Atchison, Topeka & Santa Fe extension to Chicago. The Union Bridge Company has the contract for this bridge, which has been designed by Mr. Octave Chanute.

Iron-Clad for the Spanish Government.—A large iron-clad, named the *Pelayo*, constructed for the Spanish Government by a French company, was launched at Toulon, recently, having been commenced in April, 1885. The vessel is 105 meters long by 20 wide, and of 9,900 tons. The two engines are of 6,800 horse-power, which can be increased to 8,000, and the two screws, each weighing 7,500 kilogrammes, give a maximum speed of 16 knots an hour. The cost is 14,500,000f., exclusive of that of the hydraulic apparatus and artillery, and the ship will be completely equipped in another year.

Heating Railroad Cars.—Mr. Albert L. Murdock, of Boston, sends to the *Transcript* of that city the following letter: "There are at the Patent Office, Washington, 300 models for heating railroad cars and not one adopted by any railroad company in the United States and never will be until public opinion forces them to action. I will deposit $500 in bank on notice of any one equipping a train of five cars, and after running three months, if accepted by the railroad company and an order is given to equip 25 cars, the sum shall be payable on presentation of the contract to the inventor of the first method that is accepted."

Compound Engines for an Italian Iron-Clad.—Messrs. Maudslay, Sons and Field, the celebrated English engineers, are building large compound engines for the new Italian armor-clad *Il Re Umberto*. According to the contract, these engines are to be of 19,500 horse-power, which is about 7,500 horse-power more than that of any vessel yet designed for the British Navy. It is stated that they will actually indicate 21,000 horse-power, or 9,000 more than any vessel in the British Navy. These engines, completely made of steel, are expected to drive the *Il Re Umberto*, fully equipped, about 20 knots per hour.

Imports of Iron and Steel.—The total imports of iron and steel into the United States last year, as given by the Bureau of Statistics of the Treasury Department, were 1,098,562 tons, of a total value of $41,630,688; against 578,476 tons valued at $31,144,552 in 1885.

The leading articles imported were: Tin plates, 257,686 tons; steel blooms and billets, 149,287 tons; wire rods, 136,965 tons; steel rails, 41,581 tons; pig-iron, 361,768 tons; scrap-iron, 87,103 tons.

The imports of iron ore for 1886 were 1,039,433 tons, against 390,786 in 1885. This ore came chiefly from Cuba and Spain, with a small quantity from the island of Elba.

Harlem River Bridge.—The pneumatic caisson for the new Harlem River bridge, 54 by 104 feet, outside measurement, and one of the largest in this country, is making satisfactory progress. It has struck rock on one edge, 17 feet down, the rock at the other edge being 42 feet down. Drills worked by compressed air are now at work on the rock and the caisson will probably be down to place by April 1. Dynamite is used exclusively for blasting. The ma-

terial is removed exclusively through air-locks, four buckets, holding one-quarter yard each, passing through the lock at once. This caisson was built in place, a sheet pile cofferdam being built around the site, filled in with silt from the bed of the river.

Chicago Manual Training School.—This school, now in its tourth year, has made encouraging progress under the direction of Dr. Belfield. The total number of pupils enrolled is now 190. The course is a three years' one, and embraces instruction in mathematics, science, language, drawing and shop-work during the entire period. The requisites for admission are, that the candidate be at least fourteen years of age and be able to pass a satisfactory examination in reading, spelling, writing, geography, English composition and arithmetic. The school has a well-equipped wood-room, foundry, forge-room and machine-shop, and ample apparatus for teaching the various subjects in which instruction is given.

Railroads in Ecuador.—The Government of the South American State of Ecuador has granted a concession to Messrs. Finley and Wiswell, two American engineers, to build a railroad from Quito, the capital, to the port of San Lorenzo. It is understood that capital has been secured in New York. A preliminary survey has been made of the road, which will be about 120 miles long, and a practicable route has been found.

By the terms of the concession the Government of Ecuador grants a subsidy equivalent to 6 per cent. upon $27,000 per kilometer (equal to about $45,000 per mile). This grant is not in the nature of a guarantee or claim upon the revenues, but is a direct donation and is secured to the railroad company by charge upon the customs revenues of the port of San Lorenzo.

Electric Lighting in the British Navy.—The official trial of the electric light installation on board H. M. S. *Severn* took place at Chatham Dockyard, and proved entirely successful. The dynamos were Goolden-Trotter A type, one of 200 ampères, driven by a Willan's central-valve two cylinder engine at 400 revolutions, and another of 100 ampères driven by a Willan's three-cylinder tandem engine, also at 400 revolutions. The installation consisted of 171 Swan lamps of 16 candle-power, 80 volts, and two Latimer, Clark, Muirhead & Co.'s projectors, each running a search light of 100 ampères. The installation was fitted up by the firm of Goolden & Trotter, of Westminster, the entire work having been carried out by their own staff.

Suit for Infringement of the Patent of the Miller Coupler.—The case of the heirs of the late Ezra Miller against the Pennsylvania Railroad Company for damages amounting to over $100,000 for the infringement of the patents granted to Miller in 1863, 1865 and 1866 by the use of the Janney coupler was recently decided before Judge Cox and a jury in the U. S. Circuit Court in New York. This is the first time that the Miller patents have been in litigation. The Court held that the 1863 patent was limited in terms and that the Janney device did not infringe it. The Judge then directed that a verdict on the other patents should be given for 6 cents damages, which was consented to by the counsel for the Pennsylvania Railroad Company.

Coal Production of the United States.—The production of coal in the United States for seven years past is estimated by *Bradstreet's* as follows, in long tons:

	Bituminous.	Anthracite.	Total.
1880	37,138,000	25,400,000	62,588,000
1881	42,826,000	30,900,000	73,726,000
1882	51,523,000	31,550,000	83,073,000
1883	57,805,000	34,450,000	92,255,000
1884	60,000,000	33,319,000	93,319,000
1885	58,300,000	34,258,000	92,558,000
1886	66,200,000	34,814,000	101,014,000

The increase last year over 1885 was most notable in Pennsylvania, Indiana, Virginia, West Virginia and Maryland. Pennsylvania furnished all the anthracite and 44 per cent. of the bituminous coal in 1886, or over 63 per cent. of the entire product.

New Guns for the Army.—The *Army and Navy Journal* says: "We are informed that the Ordnance Department are proposing to so alter the Springfield Rifle as to avoid, if possible, the necessity for adopting a quicker firing gun in the shape of a magazine arm. Just what changes are in contemplation we do not learn. As soon as Col. Buffington, of the Springfield Armory, has completed some experiments he is conducting, they will be announced. It is not expected that the gun can be made a self-loader, but the idea seems to be to have the breech block so arranged as as to admit of the most rapid loading with the hand. Gen. Kelton has also an improvement on the Springfield gun which it is thought possesses considerable merit. He is now in consultation with the Ordnance Department with regard to it."

Lectures on Railroad Management.—Professor E. R. A. Seligman, of Columbia College, New York, delivers this winter to the students a course of lectures on railroad history and management. The course is outlined as follows:

1. Railroad history and development in the United States, England and the Continent of Europe.
2. Relations of railroads to investors in their securities.
3. Relations of railroads to the public.
4. Relations of railroads to their employés.
5. National and State legislation on railroads in the United States.
6. The question of State or private ownership of railroads.

Illinois Coal Mines.—The reports of the State Mine Inspector show that in 1886 coal was mined in Illinois in 50 counties, at 789 mines and openings. There were 25,846 employés at these mines, and 235 machines used. The total output for the year was 9,246,435 tons, a decrease of 5½ per cent. from 1885. The average value per ton at the mines was $1.11.

The reports of accidents to miners show that 52 men were killed and 169 injured, a total of 221 casualties. One life was lost for 497 employés, or one life for 177,816 tons of coal mined.

The total number of escapement shafts in mines is now 310, against 137 in 1884, and the total number of mechanical ventilating fans erected during the year was 48, making 152 now in use.

New Locomotives for the New York Elevated Roads.—The Manhattan Company is having 25 new locomotives built for its elevated lines in New York City at the New York Locomotive Works, in Rome, N. Y. Like so many of the engines on the elevated roads, the new ones are of the Forney pattern; they have cylinders 12 inches diameter and 16 inches stroke. The chief peculiarity of these engines is the use of the Belpaire boiler. In these boilers the fire-box is 55 inches long inside and 43 inches wide at the bottom, tapering to 32¼ inches at the top. The outside fire-box is 62¼ inches long and 49⅜ inches wide at the bottom, tapering to 38¼ inches at the top. The fire-box crown-sheet is stayed to the flat, external crown-sheet by stay-bolts spaced 4½ inches apart; these stay-bolts are 1 inch diameter and 22 inches long. The boiler is 42 inches diameter of barrel and has 162 tubes, 7 feet 5¼ inches long.

Electric Lighting.—Mr T. C. Martin, in the *Electrical World*, gives the following estimate of the progress made by two leading systems of electric lighting in the United States, the Brush lights representing the arc and the Edison the incandescent system. The number of lights in use has been as follows:

	Brush Lights.	Edison Lights.
1881	,000	5,122
1882	12,000	29,192
1883	24,000	64,856
1884	48,000	98,020
1885	96,000	132,875
1886	.....	181,463

Mr. Martin estimates the total investment at the close of 1886 in local electric-light plants and in establishments for the manufacture and repair of such plants at $150,750,000.

Underground Telegraphs.—At the recent annual meeting of the Associated Chambers of Commerce of the United Kingdom, Mr. Linley Watson (Scotland) moved: "That in consequence of the frequent interruption of telegraphic communication by storms, the Government be requested to take steps to have the principal lines of wires conveyed under ground." He explained that it was only intended to apply to the great telegraphic lines of communication which, in the interests of the country, it was so necessary to maintain uninterrupted, and he referred to the serious wreckage of wires last month which had paralyzed the commercial world, and said that such breakdowns would occur again and again until aerial wires were abandoned, and the main lines were placed underground. The resolution was agreed to, and it was determined that a representation should be made to the Government.

Winter Bridge over the Detroit River.—A plan for a railroad bridge over the Detroit River, to be used only in winter when navigation is closed, has been submitted by Chief Engineer J. D. Hawks, of the Michigan Central Railroad. The plan is for a bridge with two draw-spans, one with 200 feet opening near the Michigan side, and one with 300 feet opening on the Canadian side of the river. There will also be five fixed spans, one of 200 and four of 300 feet each. In addition to these, there will be a span of 400 feet over the main channel, to be removed when navigation is open.

This plan is said to have met with approval from a committee of Congress. Should it be pressed it will be strongly opposed by the navigation interests, whose representatives hold, with much

reason, that if so expensive a structure is once built, it will not be long before some plan is devised for using it in summer as well as in winter.

Continuous Brakes in England.—The return for the six months ended June 30, 1886, showing the extent to which the continuous brakes are used on the principal railways of Great Britain, has been issued. It shows that the total stock fitted with continuous brakes, complying and not complying with the requirements of the Board of Trade, for the six months ending June 30 last, and the stock not so fitted were:

	Locomotives.		Carriages.	
	Number.	Per cent.	Number.	Per cent.
With continuous brakes....	6,631	89	43,238	83
Without continuous brakes	849	11	8,552	17

Of the total train mileage reported on the railroads for the half-year, 84 per cent. was run by trains with continuous brakes.

During the half-year 358 engines and 3,030 carriages were added to the number provided with continuous brakes.

Railroads in Porto Rico.—The Spanish Consul at New Orleans, Senor Don Arturo Baldasano y Topete, has received a circular from the home government requesting him to call the attention of the public to a recent decree concerning the construction of several railroads in Porto Rico. The Government promises the parties who may secure the contract an interest of 8 per cent. on the capital which will be invested by it, and also the exclusive control of the roads during 99 years. The work is to be completed in 6 years. A bond of $300,000 and a deposit of $100,000 are required by the contract. Mr. Baldasano states that the work to be done consists of five railroads, which will web the island so that every place will be in close communication. The Consul thought this was an opportunity for some southern enterprise to do well, and therefore stands ready to give any further information desired.

National Association of Stationary Engineers.—This Association has issued a circular setting forth its principles as adopted at the annual convention held in Boston in September last. The Association is not intended to be a trades-union in the ordinary sense, but an association for the purpose of elevating the trade and putting it on a better footing than heretofore. The objects sought to be attained are stated in the circular as follows:

"1. To elevate the profession.

"2. To secure a legal or recognized status for operating steam engineers.

"3. To elevate and help its members.

"4. To secure the confidence of steam users.

"5. To prevent entirely the explosion of steam boilers.

"6. To permit only licensed engineers to operate boilers under pressure."

The Heaviest Gun Made in England.—The first 110-ton gun, the heaviest weapon ever made in England, was safely conveyed to the proof butts at Woolwich Arsenal, recently, for the purpose of undergoing its preliminary trials. The gun had previously been placed on the carriage from which it will be fired, and this, being fixed on a broad-gauge trolly, was easily taken over the Arsenal railway by four large locomotive engines. The carriage weighs nearly 100 tons, independently of the gun. The bore of the gun is 16¼ in., and it will fire a projectile of 1,800 lbs. weight, but the charge of powder cannot be determined until after full trial. The proof will begin with a small quantity and be gradually increased as the powers of the gun are demonstrated. A new powder, specially manufactured for very large guns at the Government works, Waltham Abbey, will be employed in the experiments. The gun was supplied under contract by the Elswick firm.—*Engineering.*

Prices of Rails.—The *Iron Age* gives an interesting statement of the prices of steel and iron rails in the United States for a series of years. For the 13 years from 1848 to 1860, inclusive, the average price of iron rails was $58 per ton, the highest price being $81 in 1854, and the lowest $43 in 1851. In the 13 years from 1861 to 1873, inclusive, the average price was $78.15, the highest price being $153.75 (currency) in 1864, and the lowest $36.50 in 1861. For the nine years from 1874 to 1882, inclusive, the average price was $44.43 per ton, the highest being $68 in 1880, the lowest $32.50 in 1877. With 1882 the manufacture of iron rails in this country practically ended, and the substitution of steel on the market was complete.

The price of steel rails in the 13 years from 1874 to 1886, inclusive, ranged from an average of $94.25 per ton (the highest) in 1874, to an average of $28.50 (the lowest) in 1885. The average price for the 13 years was $51.39. The highest single quotation was $117.50, early in 1874; the lowest, $26 in 1885. The present price is about $40, which is above the average for the four years from 1883 to 1886, inclusive.

Lifeboat Services.—It is reported that in England during the past year service in saving life was rendered by the gallant crews of the lifeboats of the Royal National Lifeboat Institution, resulting in the rescue of 601 persons from danger, and in most cases from death. In addition to this long list of services in saving life, it should be added that as many as 33 vessels were saved by the lifeboats from total destruction, or were helped by them into a haven of safety. Besides the launches resulting in the saving of life, the lifeboats put to sea as many as 147 times in reply to signals of distress, only to find either that their aid was not really required, or that the signals had been made in error or improperly.

In the year the Society also gave rewards for the saving of 160 lives by means of shore-boats, fishing-boats and other means, so that the Institution was instrumental in rescuing a grand total of 761 lives during 1886, bringing up the number of lives it has saved since its foundation to 32,671.

Heating Cars by Hot Air.—A new method of heating cars from the locomotive is to be tried on the Allegheny V ley road. The details are not yet completely arranged, b the general plan is described as follows by General Superintendent David McCargo: "Heated air is absolutely safe, and can be generated from the locomotive at a trifling expense. The principle is similar to the air-brake principle and just as practicable. An air-pump forces the air along the cars for the brake system. Why should a pump not force heating air also? Plenty of air could be had from the fire-box of the engine. There is always plenty to spare, and in fact large quantities wasted. The hot-air method would cause no danger, because if any break occurred there would be no possible chance of fire or explosion. Of course if this plan is adopted all locomotives will be equipped with suitable appliances to carry it out. I mean both freight and passenger engines, because the former are sometimes used on passenger trains."

Railroad in the Arctic Circle.—English papers announce the opening of the Lulea-Ofoten railroad, which extends from Gellivara in Swedish Lapland to the port of Ofoten on the west coast of Norway. The road is built to carry iron ore from the mountain range near Gellivara to Ofoten, whence it will be shipped to England. This ore is said to contain 70 per cent. of metallic iron, and with the opening of the new railroad it can be delivered at English ports at about the same price per ton as the Spanish ore from Bilbao, which is only 50 per cent. metallic iron. Gellivara is in latitude 67° north, so that the eastern terminus of the road is north of the Arctic Circle. Ofoten is only a little south of that circle, but it is stated that the influence of the Gulf Stream keeps the average winter temperature down to about 28° Fahr., so that no trouble is expected from the closing of the port by ice. It may be supposed, however, that a railroad so far north would have some trouble from snow, especially as much of the line is in a mountain country.

Cost and Consumption of Oil on British Railways.—The detailed accounts of the Manchester, Sheffield & Lincolnshire Company, says *The Engineer*, show a result which will surprise many of our readers in the fact that the saving effected in the locomotive department—the chief one in economy—is due, in a great measure, to "oil and tallow." That a saving of nearly £2 000 could be effected in this one item alone need not be cause for astonishment, when we consider the enormous consumption of these articles for lubricating and illuminating purposes. A contemporary gives the annual consumption of oil upon the railways of the United Kingdom roughly, as follows: Engineer's department, £30,000. Locomotive department, running, £225,000; shops, £25,000; carriage lighting, £40,000. Traffic department, £40,000; general offices, etc., £10,000. Total estimated cost, £370,000; or, say, at 6d. per gallon, 14,800,000 gallons a year. The average cost per train mile of "oil, tallow and waste," in the locomotive running expenses is 0.267d. per train mile. Oil by itself may be taken at about 0.2 per train mile, which, on a fair aggregate mileage, would give the £225,000 above estimated as the cost in this department on all the lines.

New York Underground Railroad.—This company has been reorganized, and a contract for building the road has been let to the United States Subway Company. Application has been made to the Commissioner of Public Works for authority to open the streets in order to begin the work. The excavation required will be 25 feet wide and 15 feet deep. The directors claim that the company's charter

gives all the authority needed to build the road, and that nearly all the property owners along the proposed route are in favor of it. The proposed route is from Broadway, under City Hall Park to Brooklyn Bridge, thence up Center street to City Hall Place, thence to Mulberry Street, northerly to Bleecker Street to Lafayette Place, under Lafayette Place to Astor Place, under Astor Place and Poole's Theatre to Fourth Avenue at the Stewart Building, thence north under Union Square to Broadway, up Broadway to Eighteenth Street, thence to Madison Avenue and under Madison Avenue to the Harlem River.

A branch will run from Broadway and Eighteenth Street to the southwest corner of Central Park, and another branch from City Hall Park to the Battery.

Coast Survey Work.—Lieutenant Pillsbury, commanding the *Blake*, has started south for the season's work, and will run several lines of current observations from Cuba to Yucatan, and from Cuba to Florida Reef, and thence northward to San Antonio. This is a continuation of the work of last year, which was so successful. The connection between the velocity of the Gulf Stream and the advent of the tidal wave on our coast has been accurately determined, and the credit for this important discovery is due to Lieutenant Pillsbury.

The steamer *Patterson*, which has been laid up since last October at the Mare Island Navy Yard, is being overhauled and painted, to return to survey work on the Alaska coast early in the coming spring.

Lieutenant William H. Emory, who commanded the *Bear* on the Greely relief expedition, has been ordered to the *Thetis* and will shortly sail for Alaska. He will investigate the seal-fisheries, and has received special instructions regarding the boundary line between Alaska and the British possessions.

Racing Yacht on a New Model.—Lieutenant S. Seabury, U. S. N., has designed a new type of sloop yacht which is a compromise between the "skimming-dish" and "cutter." The vessel submitted has been given a load line as fine aft as it is forward while the smaller angles of the cross sections with the center line insure a smaller change in the flotation plane by inclination. Naturally, a loss of initial stability results, but then the greater draught enables ballast to be carried where it will do the most good. The proposed vessel has her greatest draught at the middle of her length, which is also her greatest cross section. The *New York Herald*, which publishes plans of Lieut. Seabury's yacht, says: "As an interesting experiment her plans are worthy of close study, and her performance when built will be watched with eager curiosity by nautical men. Her designer believes in her, and if she accomplishes half what is claimed for her she is perhaps destined to make a great revolution in the present methods of yacht construction in both the United States and Great Britain."

New York Water Supply.—The New York Aqueduct Commission has resolved, with only one dissenting vote, in favor of building the proposed Quaker Bridge Dam, in order to provide an additional storage reservoir. The water-shed of the Croton River, it is believed, will yield a sufficient supply for the city for many years to come, but the present storage capacity is insufficient, and in seasons of high water much water passes over the dam and is wasted. The new dam will form a reservoir or lake holding about 34,000,000,000 gallons more than can be stored at present.

The proposed new dam, if built in accordance with the preliminary plans submitted by the Engineers, will be 1,025 feet long. It will be in the center 178 feet high from the present bed of the river and 278 feet from the rock foundation, which will be 100 feet below the river-bed. It is below the old Croton Dam and will be about 35 feet higher than that structure, which will thus be submerged entirely when the reservoir formed by the new dam is full.

This vote of the Commission closes a long controversy over the best means of meeting the difficulties in the case.

A Prairie Snow Yacht.—Dr. H. M. Wheeler, of Grand Forks, Dak., has designed and built a modified form of ice-boat for his own use. His new craft sails over the snow on the prairies at the rate of from 13 to 16 miles an hour, and even faster when there is a good hard crust on the snow. The yacht is 32 feet in length, width abeam 14 feet, mast 20 feet, main boom 22 feet, gaff 12 feet, jibboom 11½ feet. The runners are strong toboggans 9 feet long, the front ones being 1 foot, and the rear ones 6 inches wide. The front runners have a central shoe 2 feet long, projecting 1¼ inches to prevent drifting. The body of the boat is raised above the runners 1 foot. The frame work is 3 feet across the stern, and the tiller is attached directly to the rear runner. Dr. Wheeler says in his letter: "Our country is a vast table land, and, with the exceptions of ravines and water courses, is apparently as level as the floor. We have no fences, except small enclosures for stock, hence we have plenty of 'sea room.' My mast is as high as will go under telegraph wires, and even now sometimes encounters them, on which account I have rigged an iron fender, shaped like an old-fashioned figure 4, with a line running from front angle to bowsprit. When the front face of this 4 strikes a telegraph wire the wire bounds up and over it and the yacht passes along."

English Trade Unions.—An appendix to the report of the Chief Registrar of Friendly Societies for 1885 furnishes a list of 207 trade unions in England, together with details of their organization. It appears that the oldest union which is still in active existence is the Steam Engine Makers' Society, which has its headquarter at Manchester and was established in 1824. Then come the General Union of Operative Carpenters and Joiners started at Liverpool in 1827, and the United Society of Boiler-makers and Iron Ship-builders, of Newcastle-upon-Tyne, originated in 1834. Every well-known trade is represented on the list of unions, but there are also in addition such industries as stuff makers-up, card-setting machine tenters, drillers and cutters of the River Wear, Dutch yeast importers, trimmers and teemers, crabbers and singers, silk ballers, potters' mold-makers, card and blowing-room operatives, boot-top cutters, hammermen, tin-canister makers, carriage straighteners, tape sizers, chippers and drillers, and rundlet coopers. The amalgamated chimney sweeps have a separate union, as likewise have the amalgamated showmen and amusement caterers. The latter union, however, was very short-lived; founded in 1884, it was dissolved in 1886.

Russian Oil-Pipe Line.—The Russian Government has just granted a concession for a pipe-line to connect the Baku oil-fields with tbe port of Batoum on the Black Sea. The concession is to last 20 years, with the proviso that the first line shall be completed within three years. The Government not only guarantees no interest, but stipulates that the pipe-line company shall not, during the term of concession, own or have any interest in either oil wells or oil refineries. Wherever the lines traverse Government lands, no charge for right of way will be made, and everywhere the company will have the same rights and privileges as are granted to railroads. One-third of the pipes must be constructed in Russia, unless such is proved to be impossible. The tariff for the pumpage of the oil has been fixed at from 10 to 11 copecks a pound, equal to about 1.10 cents a gallon.

The whole length of the line will be 603 miles. The pipe-laying will be easy all along, except where the line crosses the Caucasian Mountains This will be accomplished at the Suram Pass, which is about 3,000 feet above the sea-level, by a series of pumping stations furnished with large Worthington pumps. The gravity of the oil itself will carry it from the summit of the pass down to the sea-level at Batoum.

Open-Hearth Steel Production.—The American Iron & Steel Association gives the production of open-hearth steel in the United States last year at 245,606 tons, against 149,381 in 1885.

"The output of open-hearth steel in 1886 was produced by 31 old and 8 new plants, located in eight States—New Hampshire, Massachusetts, New York, New Jersey, Pennsylvania, Ohio, Illinois and California. Of the new plants one is in Massachusetts, 6 in Pennsylvania and one in Ohio. Three open-hearth plants built prior to 1886 were not in operation in that year. At the close of 1886 there were also 9 new open-hearth plants which had either been built in that year but not put in operation, or were then building or were projected by responsible parties. Of these 5 were in Pennsylvania, 2 in Ohio and 2 in Indiana.

"Pennsylvania's share of the total production of 1886 was over 70 per cent.

"The quantity of open-hearth castings produced in 1886 was not materially larger than in previous years, and was relatively very small. The quantity of open-hearth steel rails produced in 1886 by open-hearth works was also very small, amounting to only 5,255 net tons, which were made in Pennsylvania and California. Of the whole quantity 2,518 net tons were street rails."

Transmission of Power by Compressed Air.—A company is about to make the experiment in Birmingham, England, of transmitting power by compressed air over an area of about one square mile and a half, which will include about twenty-three miles of main pipes. Commenting on this a writer in *Nature* says:

"This is the first time that an experiment of this kind has been tried in Britain. Power is distributed from a central station at Hull by the hydraulic system, but transmission by air

has hitherto only been tried in small installations at mines, quarries, in sinking piers, as at the Fourth Bridge, and in tunnel-boring. In mines and tunnels it has very evident advantages, in that it keeps up a continual supply of fresh, cold air where ventilation is very much needed; and therefore its undoubted success at the St. Gothard works does not demonstrate its certainty of success for the distribution of power on a large scale to the workshops of a town where the atmosphere is bareably pure. Moreover, the pipe system of these small installations have not been sufficiently long and complicated to test in any severe sense the liability to loss by friction, leakage and variation of temperature.

"The results of the present experiment will therefore be of the utmost scientific value to engineers, and will be watched with corresponding interest."

School for Inventors.—Professor R. H. Thurston writes to the *Scientific American* that a pet project of the late John Roach was the foundation of a school for inventors. In this school he "would make it possible for the needy inventor to find all the tools, apparatus for experimentation, facilities for construction and operation of his invention; whatever, in fact, he might in any way find useful in its development, and even the aid of experienced mechanics and of learned men of science, all placed freely at his disposal; so that he might, quietly and comfortably, go about his work with an assurance that, if there was anything at all in his notion, it should be most certainly and promptly and effectively given working form and useful application.

"Mr. Roach believed, as he said, that such an institution might, if properly organized and well managed, be made to return to the country many times its cost by securing the immediate development of valuable inventions and their prompt applications where, without such aid, they might lie dormant and useless for years, or even be lost to the world altogether. As he put it, the successful development of a single such invention might give to the world the equivalent of millions of dollars in facilitating production, saving lives and property or in promoting the comfort of the people."

Mr. Roach died before he felt himself in a position to carry out this project, and his ideas remained undeveloped.

New Use for Blast-Furnace Slag.—The *American Manufacturer* says that Mr. John Q. Everson and two well-known capitalists of Pittsburgh are organizing a company for the purpose of converting blast-furnace slag into mortar and other building material.

Mr. Everson has experimented for some time and finds that if certain materials, known to himself, are added to the slag when it is run from the blast furnace into a pit prepared for that purpose, that it forms a hard substance suitable for making mortar, pavements, etc.

It is the intention of the new company to at once erect a plant convenient to some large blast furnaces. The capital stock will be sufficient to erect a plant large enough to supply the demand for material next year.

After experimenting with this slag compound for nearly three years, Mr. Everson has arrived at the conclusion that the uses to which it can be put are manifold, and he feels certain that before many months its manufacture will be one of the great industries of Pittsburgh and vicinity. His experiments, he claims, have shown him that blast-furnace slag makes the best and cheapest mortar. The bricks are durable and do not require any kiln drying. The blocks made from it can be used in place of stone sills, lintels, cornices and belting course. It is excellent for cellar walls, as it keeps out all dampness. It will also, it is claimed, make a substantial and durable pavement. The making of subway conduits for electric wires is another use suggested for the new material.

Hardened Petroleum as Fuel.—A report recently made to the Russian Government by Dr. Kauffman says: "Petroleum, which is a hydrocarbon of the so-called methane group, may be saponified just like the oils, fats, fatty acids and wax, thus oxidizing the oil and combining it with soda or potassa salts. For this purpose the oil is heated, and from 1 to 3 per cent. of its weight of common soap is added, with which it is boiled for about half an hour. After that time it will be noticed that the soap is all dissolved in the oil, and the fluid will suddenly turn into a hardened putty-like substance which will get as hard as stiff tallow when cold. This may be pressed into any shape desired. The substance is very hard to light and burns very slowly, without making any smoke, with a reddish flame producing great heat, and leaving about 2 per cent. odorless, black and hard residuum. Compared with coal, it burns about three times slower, producing, if the draught be well regulated, about seven times more heat than anthracite coal. It could well be used in a stove specially constructed for the purpose, or in the old stoves, if these are changed, which will not be very difficult. It is, therefore, very probable that petroleum will take the place of coal in many instances, in the near future, which fact stove manufacturers will have to take into consideration."

Should these statements prove correct, it is claimed that solidified petroleum can be put on the market at lower rates than coal, as it can be piped to convenient points at less expense than coal can be carried, and the works for solidifying can be placed wherever desired.

Steel Rail Production.—The production of Bessemer steel and steel rails for last year and 1885 is given by the *Bulletin* of the American Iron and Steel Association as follows, in net tons:

	1886.	1885.	Increase.
Ingots	2,541,403	1,701,762	839,731
Steel rails	1,749,899	1,074,607	675,292

Last year 69 per cent. of the total production of steel ingots was converted into rails, against 63 per cent. in 1885.

Last year 59 per cent of the ingots and 63 per cent. of the rails were made in Pennsylvania; 21 per cent. of the ingots and 25 per cent. of the rails in Illinois, the balance in other States.

The production, both of ingots and rails, was the largest on record in the United States. In the total production of ingots 46,371 tons made by the Clapp–Griffiths process are included.

The *Bulletin* says: "The extraordinary production of Bessemer steel in 1886 was chiefly the result of great activity by the large plants of the country which had been established prior to that year. Only a small part of it, about 100,000 tons, was due to the starting up of new plants. * * It is just 20 years since Bessemer steel was first made in this country as a commercial product. In 1867 we made 2,277 gross tons of Bessemer steel rails. In recent years we have frequently made more Bessemer steel ingots and more Bessemer steel rails than Great Britain, but, as our production of open-hearth steel was always much less than that of the mother country, we could never until now say that our aggregate production of steel exceeded hers in any year. In 1886, however, we not only made more Bessemer steel ingots and Bessemer steel rails than Great Britain, but our aggregate production of steel, open-hearth and crucible included, was very much larger."

Blast Furnaces of the United States.—The record kept by the *Iron Age* gives the number and capacity of furnaces in blast in the United States on February 1 as follows:

Fuel.	Number.	Weekly Capacity.
Anthracite	136	40,956
Bituminous and Coke	144	78,957
Charcoal	58	9,649
Total	338	129,562

As compared with January 1, the anthracite furnaces show an increase of 6 in number and 220 tons in weekly capacity; the bituminous furnaces, an increase of 7 in number and 5,535 tons in capacity; the charcoal furnaces, a decrease of 1 in number and 1,052 tons in capacity.

New Railroad Built in 1886.—The following statement of new railroad built in the United States in 1886 is issued by Messrs. Poor & Greenough, publishers of *Poor's Manual:*

	Miles.
New England	41
Middle States	374
Central Northern States	1,232
South Atlantic States	1,019
Mississippi Valley States	339
Southwestern States and Territories	2,427
Northwestern States and Territories	2,578
Pacific States and Territories	638
Total	8,648

"This makes the total mileage in the United States at the close of the year 137,615 miles. The reports received from the various railroad companies, of work which is in progress or under contemplation, indicate that construction during the year 1887 will amount to not less than 12,000 miles, unless some serious convulsion should occur to reverse plans which are now entertained.

"This estimate is confirmed by engagements which have been made in advance for the current year with rail mills and other manufacturers of railroad plant."

Portable Railroad Bridges.—A late number of *La Genie Civile* describes a new system of portable railroad bridges, for which simplicity of construction and ease of erection are claimed. The bridges are constructed of a number of triangular pieces formed of angle-iron joined together by gussets riveted in the workshop. The pieces are bolted together to form continuous girders up to a length of 148 feet, and, being made of steel, can bear a strain of 6⅓ tons per square inch of section. The triangles are isosceles, 20 feet long and 10 feet high and weigh 802 lbs. and are the heaviest parts of the bridge. Each girder is terminated by a half-piece 10 feet long, and provided with an upright, and weigh-

ing 639 lbs. The ties are of an angle-iron form, 10 feet long, and weighing 386 lbs. The above pieces serve for the construction of three different types of girders—namely, a single girder, 10 feet 1 inch high, for bridges up to 49¼ feet span; a double girder of the same height for bridges not exceeding 98½ feet span; and, lastly, a double girder, 19 feet 4 inches high, for bridges of from 98½ to 147¾ feet span. The weight of these bridges varies between 13½ tons for bridges of 49¼ feet span and 77½ tons for the heaviest form of bridge of 147¾ feet span. It is stated that, owing to the small number of bolts required to connect the several pieces, the lightness and small number of parts and the simplicity of the joints, the erection of the girders is both simple and rapid, and can be effected on scaffolding or by rolling out. One of these bridges has been used for the passage of the Orleans Railway across the river Oust during the rebuilding of three bridges crossing the river. The same bridge was employed at the three sites successively, and the largest of the four spans, having a length of 88½ feet and weighing 33 tons, was put together and rolled out into position in twenty hours. This bridge bore the trial test-loads without any permanent deflection; it carried the traffic for about 150 days altogether, and, like other bridges of this type, proved satisfactorily rigid.

Pig Iron Production in the United States.—The *Bulletin* of the American Iron and Steel Association says: "The production of pig-iron in this country in each year from 1880 to 1886 was as follows, in both net and gross tons.

Years.	Net tons.	Gross tons.
1880	4,295,414	3,835,191
1881	4,641,564	4,144,254
1882	5,178,122	4,623,323
1883	5,146,972	4,595,510
1884	4,589,613	4,097,868
1885	4,529,869	4,044,526
1886	6,366,688	5,684,543

"Our production of pig iron in 1886, classified according to the fuel used, was as follows, in net tons, compared with the production in 1884 and 1885.

Fuel used.	1884.	1885.	1886.
Bituminous	2,544,742	2,675,635	3,806,174
Anthracite	1,586,453	1,454,390	2,099,597
Charcoal	458,418	399,844	460,917

"The anthracite figures include all pig-iron made with mixed anthracite and coke, as well as that made with anthracite alone. In 1886 the total quantity of pig-iron made with anthracite alone was only 443,746 net tons.

"There was a gratifying increase in our production of spiegeleisen in 1886, which is included in the figures of total production of pig-iron. We made 47,982 net tons in 1886, against 34,671 tons in 1885. Only New Jersey and Pennsylvania made spiegeleisen in 1885, but in 1886 Colorado made 932 net tons in addition to the production of the two other States mentioned.

"The gain in production in the last six months of 1886 over the first six months was chiefly in Pennsylvania and Illinois. The total gain in the country at large was 458,270 net tons, and to this gain Pennsylvania and Illinois jointly contributed 320,238 net tons. The great activity in the manufacture of Bessemer steel in these two States in the last half of the year mainly accounts for their increased production of pig-iron."

Technical Education.—At the last meeting of the School Principals' Association in New York, Dr. W. H. J. Sieberg gave a lecture on Technical Education. After saying that the question of introducing manual training into education dated back two centuries, Dr. Sieberg said the reasons which called for technical education were most pressing. They were manifest in the almost universal tendency of public school pupils to enter the professions or clerical pursuits, leaving skilled labor to be undertaken by foreigners. This distaste for manual labor and contempt for all kinds of mechanical arts is the natural result of the almost exclusive training of memory and the reasoning powers. Education should fit a man to work with his hands and eyes as well as with his memory. The pupil should not be influenced in the direction of commercial pursuit any more than in the direction of any of the trades. One of the greatest difficulties to overcome was the education of the teachers themselves. They, as yet, did not understand what was to be taught.

Mr. Henry Leipziger, Principal of the Hebrew Technical Institute, at No. 34 Stuyvesant Street, New York, followed with an address warmly advocating the introduction of technical training and emphasizing the difference between it and industrial or trade instruction. He showed some wonderfully good specimens of mechanical drawing, joinery and casting done by boys in his school between the ages of 12 and 14. He stated that in the three years in which his school had been in existence not one case which could be called a breach of discipline had occurred. "Whatever evil there may be in the boys," said Mr. Leipziger, "is worked off through their fingers, and I actually have hard work sometimes to get the boys away from the school-room at the closing hour, so fully are their energies engaged."

Considerable discussion followed this address, and the general opinion was that though New York public schools were among the best managed and most successful in the world, the results of this technical school were, as one gentleman expressed it, "most humiliating to us as compared with the results of the old, spelling-book method."

Imperial Institute of the United Kingdom, the Colonies and India.—It is proposed to establish in London, in commemoration of the jubilee year of Queen Victoria's reign, an Imperial Institute which, as expressed by the Prince of Wales, at a recent meeting of the members of the organizing committee held in London, "will form a practical means of communication between our colonial settlers and those persons at home who may benefit by emigration. * * * I therefore commend to you as the leading idea I entertain that the Institute should be regarded as a center for extending knowledge in relation to the industrial resources and commerce of the Queen's dominions. With this view it should be in constant touch, not only with the chief manufacturing districts of this country, but also with all the colonies and India. * * * The Imperial Institute should be a supplement to, and not a competitor with, other institutions for technical education in science and art both at home and in the colonies. At the same time, I trust that the Institute will be able to stimulate and aid local efforts by directing scholarships for the working classes into suitable channels, and by other similar means. (Hear, hear!) Though the Institute does not engage in the direct object of systematic technical education, it may well be the means of promoting it as its purpose is to extend an exact knowledge of the industrial resources of the Empire. It will be a place of study and resort for producers and consumers from the colonies and India when they visit this country for business or pleasure, and they, as well as the merchants and manufacturers of the United Kingdom, will find in its collections, libraries, conference and intelligence rooms the means of extending the commerce and of improving the manufacturing industries of the Empire."

At another meeting to promote the Institute, Professor Huxley said that "his memory went back far enough to call to mind with great vividness a period when industry, or, at least the chiefs and the leaders of industry, looked very much askance at science. The practical man then prided himself on caring nothing for it, and made it a point to disbelieve that any advantage to industry could be gained by the growth of what he was pleased to call abstract and theoretic knowledge. But within the last 30 years, more particularly, that state of things had entirely changed. There began in the first place a slight flirtation between science and industry, and that flirtation had grown into an intimacy, he might almost say courtship, until those who watched the signs of the times, saw that it was high time that the young people married and set up an establishment for themselves. (Laughter and cheers.) This great scheme from his point of view was the public and ceremonial marriage of science and industry. (Hear, hear!) It was the recognition on the part of those persons who were best able to judge of what were the wants of the industry of the time, that if they were to be developed in a way proportionate to their importance they must be developed by scientific methods and by the help of a thoroughly scientific organization."

A Locomotive for Sharp Curves.—The Taunton Locomotive Works have just completed a locomotive for local passenger service on the Providence, Warren & Bristol road, which has been built with special reference to working over the very sharp curve by which that road enters Providence. This curve was laid out about a year ago by Mr. Waterman Stone, Superintendent and Engineer of the road. Beginning with a radius of 271 feet, the radius of curvature decreases every 50 feet until a minimum of 211 feet is reached. At the end of this curve the radius is increased every 11 feet until a tangent is reached.

The new locomotive, which is named the *Annawomscutt*, is of the Forney pattern with the addition of a four-wheel truck in front. It has 17 × 20 inch cylinders and drivers 63 inches diameter; one pair of drivers have flanged tires 5¾ inches space, the other blank tires 7 inches face. The driving-wheel base is 6 feet 9 inches; the total wheel base, 31 feet 2 inches. The boiler is 54 inches diameter of barrel, and has 170 tubes 2 inches diameter and 10 feet 10 inches long. The fire-box is 60 inches long and 34½ inches wide inside; the fuel is soft coal.

The arrangement of the trucks is described as follows: "The engine and tender are all borne on one rigid frame, in which the four coupled driving-wheels are placed as in an ordi-

nary eight-wheeled engine. There is a leading truck of four wheels and a tender truck of six wheels. The engine is set upon these two trucks in a new and quite peculiar manner, and on their smooth working depends her successful passage of the great curve. The trucks are both swiveling upon a center bearing and oscillating, having a play or slide of 1 foot, or 6 inches right and left. The center bearing of the truck is made broad and concave, the angle of inclination of the sides of the dish-shaped bearing differing in the tender trnck from the leading truck on account of the greater weight at that end of the machine. Between this and the complementary convex bearing, supporting the frame on either truck, are interposed hard steel rolls, the forward truck two and the tender truck four, working freely in their bearings. When the engine strikes a curve the extremes of the frame will be carried out over the outside of the curve, and the trucks following, the rails will bring the weight upon the roller bearings, which will tend to bring the truck back to the true center bearing when the tangent is reached. The trucks at the extremes of the machine thus looking after themselves upon curves the rear pair of drivers only need strictly follow the main line of track, the broad tread of forward drivers, which are blank, allowing a considerable side motion. The engine truck is entirely forward of the cylinders, and its wheel-base is but 3 feet 2 inches, reminding one of the close-wheeled leading truck of an old-fashioned inside-connected engine."

The engine truck wheels are 26 inches, and the tender wheels 30 inches diameter; they are all of Krupp steel.

The engine weighs, empty, 99,700 lbs., of which 13,500 lbs. are on the forward truck, 55,000 on the drivers and 31,200 lbs. on the tender truck. The tank will hold 2,200 gallons of water, and the tender will hold three tons of coal.

The Size of Ocean Steamships.—The following table gives the name, date of contruction, tonnage, length, breadth and depth of the principal steamships plying between European and American shores:

Name.	Built.	Gross tonnage.	Length.	Beam.	Depth.
City of Rome	'81	8144	546	52	37
Umbria	'84	7800	500	57.2	38.1
Etruria	'84	7718	501.6	57.2	38
Servia	'81	7392	515	52.1	37
Aurania	'82	7269	470	57.2	37.2
Le Bretagne	'86	7012	508.4	52.4	38.4
La Bourgogne	'86	7000	508.6	52.2	38.8
La Champagne	'86	7005	508.7	51.6	38.4
La Gascogne	'86	7008	508.7	52.2	38.3
Alaska	'81	6932	500	50.6	38
America	'83	6500	432	51.3	35.8
Normandie	'82	6062	459	50	37
Westernland	'83	5736	455	47	35
Saale	'86	5500	455	48	38
Trave	'86	5500	455	48	38
Aller	'86	5500	455	48	38
City of Berlin	'74	5491	488.6	44.2	34.9
Noordland	'83	5212	400.7	47	35.3
City of Chicago	'83	5202	430	45	33.6
Eider	'83	5200	450	47	33.6
Arizona	'79	5147	464	46	37
Ems	'84	5129	430.5	47	34.5
Fulda	'83	5109	450	46	36
Werra	'82	5109	450	46	36
Belgravia	'81	5080	398.2	44.5	32.2
Germanic	'74	5008	455	45.2	33.7
Britannic	'74	5004	455	45.2	33.7
Elbe	'81	4911	420	45	36.5
England	'65	4898	437	42.5	35
Egyptian Monarch	'80	4709	370	44	35.8
Egypt	'71	4610	440	44.3	36.5
France (Fr.)	'65	4647	384	44	36
Amerique	'64	4637	394	42.0	36.9
City of Richmond	'73	4607	452.6	43	36
Erin	'64	4500	415	41	35
City of Chester	'73	4565	475	44.3	35
Spain	'71	4512	425.4	43.2	36.2
City of Montreal	'71	4451	419.1	44	34.3
The Queen	'65	4457	381.1	42.4	37.3
Grecian Monarch	'82	4364	381	43	33
Greece	'63	4310	390.7	41.3	35.3
Devonia	'77	4269	400	42	32
Hammonia	'82	4247	375	45	34
Italy	'70	4169	389	42.3	38.7
Anchoria	'74	4168	480	40.1	33.8
State of Nebraska	80	4000	385	43	34
Ethiopia	'73	4005	402	40.2	33
Lydian Monarch	'81	3916	360	43	32.4
Adriatic	'71	3888	437.2	40.9	31
Celtic	'72	3867	437.2	40.9	31
Denmark	'65	3724	342.9	42.2	36
Republic	'71	3707	420	40.9	31
Baltic	'71	3707	420	40.9	31
Suevia	'74	3704	360	41	34
Wisconsin	'70	3700	378	43.2	32

Other well-known ships are the *France*, *State of Nevada*, *State of Pennsylvania*, *Monarch*, *Rhynland*, *Abyssinia*, *Australia*, *Lessing*, *Wyoming*, *Rugia*, *Belgenland*, *Wieland*, *State of Alabama*, *Westphalia*, *Pennland*, *Zeeland*, *Assyrian Monarch*, *State of Georgia*, *Bohemia*, *State of Indiana*, *Acadia*, *Nederland*, *Alexandria and Assyria*. These register from 3,600 to 1,082 tons. The *Acadia* is the smallest.—*The Engineer.*

Improvement of New York Harbor.—At a recent meeting of the Engineers' Club of Philadelphia, Prof. L. M. Haupt made some remarks on the plans for the improvement of New York Harbor, and on a pamphlet on the subject recently issued by the New York Chamber of Commerce. These remarks are reported in the *Proceedings* of the Club as follows: "He said, with reference to the jetty plan proposed by the Board of U. S. Engineers, that he had previously given his comments in his papers entitled Harbor Studies, which are now published in Vol. V, No. 4, of the *Proceedings*. There were a few statements, however, in the circular issued by the Chamber of Commerce to which he desired to call attention, since he believed that the plan proposed in said pamphlet was based upon a misconception of the intensity of the forces operating at the outlet of the East Channel.

"In describing the forces available for the purpose of maintaining a channel by tidal currents, the author of the paper has divided them into two principal groups. One, composed of the waters passing through the Narrows; the other, of those from Raritan Bay and its adjacent drainage areas. The report then adds: 'Both of these forces pass seaward between Sandy Hook and Coney Island, being divided by the Dry Romer Shoal, and it is estimated that the quantities of flood-tide waters are almost identical on either side of the shoal, while the ebb-tide waters are from 10 to 15 per cent. stronger over the East Bank and through the channels north than through the channels on the south side of the shoal. It is probable that none of the waters that pass through the Narrows on the ebb tide ever flow south of this shoal, except at the seaward end of the bar, and under special conditions, such as high freshets, or the backing up of the waters by unusual winds.'

"If this statement were true, Sandy Hook would soon be cut down to a short spit, and the main ship channel, instead of having over 67 feet in depth, would become subordinate to the East Channel. Moreover, were there no considerable stream of water flowing south of the west end of the East Channel, there could be no cause for the well-defined valley extending into Sandy Hook Bay. The form of the bottom is such as to contradict most emphatically this statement. There can be no doubt but that a large portion of the discharge passing through the Narrows impinges upon the New Jersey shore of Sandy Hook Bay, is then reflected along the west side of the Hook, and thence deflected to the eastward through the main channel. At the mouth of the East Channel there is a bar at least two miles in length between the 30 feet curves, and having, according to the latest surveys, a least depth of 19.5 feet, requiring the removal of over 4,600,000 cubic yards. To remove this, there is a *surface* resultant of considerable power operating in the direction of the ebb tide, but which, according to Prof. Mitchell, does not extend to a depth of 12 feet, and consequently can have no material effect upon the bottom. At Gedney's Channel, on the contrary, the bar is but ¾ mile in length with a least depth of 23.3 feet and containing only 760,000 cubic yards, whilst the resultant scouring forces extend to below 30 feet at a point just inside of the entrance. All the reports agree in stating that the tidal forces in this channel exceed those of any other locality. Hence, it is believed that, notwithstanding the desirability of improving the shorter route *via* the East Channel, the cost and difficulties of such an undertaking by tidal scour would be so great as probably to render it impracticable, whilst the conditions at the head of Gedney's Channel are exceptionally favorable for such an improvement.

"The limited resources of the engineers having charge of works of this description is shown by the following extract from a report made upon one of the most important ports of entry in the Gulf. 'Deeper water on the bar is needed, and the question to be considered is, how that deep water can be obtained. The methods are two: (1) by dredging alone; (2) by using tidal scour between jetties, aided, if necessary, by dredging. As to the first method, it has already been tried unsuccessfully,' etc.

"From this statement it appears that the element of deflection of surface currents by means of floating deflectors for the purpose of producing bottom scours, does not appear to have entered into the problem; and yet it is believed to be a more important and potent factor than any hitherto considered. It was believed by the speaker that a combination of this principle of vertical deflection, with an increase in the prism of discharge through any given section, by properly arranged lateral wings, would secure the desired depth with a comparatively small expenditure of time and money.

"Copies of old charts of the vicinity of Sandy Hook were also exhibited, extending back over 150 years and showing a minimum depth on the bar of 3.5 fathoms, as well as the phenomenally deep basin at the western end of Gedney's Channel, to which allusion has been made in the Studies recently submitted."